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CONCRETE AND BRICKWORK IN FOREST ENGINEERING.

The great advance which concrete has made in Indian building practice of recent years is apt to be looked upon by the forest officer as a misfortune, because concrete has usurped the place of structural timber in the building trade and has thus spoiled his market, without bringing him any equivalent gain in his own construction work. There is no doubt that concrete has come to stay and we need not waste time over vain regrets at losing so much of the structural timber market, which is already moribund in some parts of the country. Instead we must set to work to develop other uses and markets for our timbers and also let us see what use concrete can be in our own work. There is no doubt that concrete is preferable to wood or to the old-fashioned lime plaster for many of the "odd jobs" in building construction and repairs, such as office and verandah floors, bath platforms, kitchen *chulis,* garage pits, and so forth, while the use of reinforced concrete in slabs and beams can greatly simplify common problems in building, such as providing massive lintels for enlarged office windows, or short bridge spans and culverts to carry the increasingly heavy traffic which motor and lorry transport is bringing on to our forest roads.

In many parts of the country concrete has been used in buildings and construction works with rather lamentable results. In many cantonments and hill stations one can see concrete fence posts and culverts so badly made that they are falling to bits much more quickly than timber structures would have done, and similar examples of bad concrete work are all too common in our forest buildings. It is unlikely that the fault lies in the quality of the cement supplied and it is much more probable that it occurs in the handling of it. Most

forest building *mistris* have been accustomed to the leisurely handling of the locally made lime or the even slower setting of mud plaster, and they do not realise the vital importance of the time factor in the mixing and handling of the fast setting cements now so universally used. The secret of successful cement work is undoubtedly in following closely the manufacturers' instructions, and in this connection we would call attention to the many useful pamphlets and instructions upon the various uses of cement which are supplied to any enquirers by the India Cement Association, Bombay.

To those who are shy of embarking upon cement concrete work with the unintelligent "jungly" labour which as a rule is all that the forest man has at his command, we would recommend a compromise by using locally made bricks in conjunction with metal reinforcing rods. The theory and practice of reinforced brickwork has been very fully worked out by a Public Works Department Officer, Mr. A. Brebner, C.I.E., in his "Notes on Reinforced Brickwork" (G. of I., P. W. D., Technical Paper No. 38 of 1923 in 2 Volumes: Volume I, Notes: Volume II, Illustrations, Tables and Plans. Superintendent of Government Printing, Calcutta, prices Rs. 1 and Rs. 11 respectively, but Volume I now out of stock).

Construction is in all essential features the same as for reinforced concrete except that brickwork in cement mortar is substituted for cement concrete. Mild steel round rods of $\frac{1}{4}''$, $\frac{5}{16}''$, or $\frac{3}{8}''$ are used packed in the mortar between parallel rows of bricks, and with their ends turned up into a large hook, which forms an additional anchor in the mortar. In addition to its use in door and window openings where a flat lintel of reinforced brick is an obvious improvement on a relieving arch of ordinary brick, it is also widely used for floors, roofs, staircases, and bridge decking. It was first introduced in the construction of the new Bihar and Orissa capital at Patna, since when it has been in regular use in Bengal and in the Government of India's new capital and also in many commercial buildings. Where bricks are good and cheap and where the constant supervision required for good concrete work cannot be guaranteed it has obvious advantages. In most parts of India the standard of brick-making is surprisingly

*good, and those mistris who have been accustomed to common brick-*laying should soon tumble to the use of reinforcing rods inserted along with the mortar. Other advantages over cement concrete work are that the supporting centering need not be so carefully constructed, provided it has the necessary strength to remain rigid under the weight of the material and workmen, and further there is no need for the elaborately carpentered " forms " which are necessary for cement.

There appears *to be no reason why good results should not be* obtained through the use of reinforced brickwork rather than by the excessive use of cement concrete in our forest construction work.

SILVICULTURAL SYSTEMS FOR SAL IN THE UNITED PROVINCES.

By E. A. Smythies, I.F.S.

In the *Indian Forester* of April 1932, an article was published by the writer, which reviewed at some length the problem of *sal* regeneration in the United Provinces, and explained why we have to a great extent lost faith in our ability to guarantee natural *sal* seedling regeneration in many of our forests when and where we wish. The object of this article is primarily to explain how this fundamental fact is influencing our forest management, and how our choice of silvicultural systems is affected. It is a natural sequel to the first article.

2. But before dealing with our immediate problems, it will be of interest to trace the gradual change and evolution of systems of management in the U. P. *sal* forests in the past.

The first proposals for systematic management are contained in a very early and interesting report written by Colonel Pearson, the first Conservator of Forests in the U. P., in 1869, at the conclusion of his first tour of inspection of the *sal* forests between the Ganges and the Sarda rivers. This interesting report gives us a vivid picture of the previous reckless ruin of all the accessible *sal* forests, (which however were everywhere rapidly and profusely regenerating naturally with protection from fire), and the overcrowded and unthinned

state of the super-stocked inaccessible (and therefore virgin) forests. His proposals for future management were briefly :—

i. In the ruined forests, simple protection, with climber cuttings and where necessary removal of hollow old stems over healthy sapling groups.

ii. In the virgin forests.

(*a*). Exploitation of I class trees (over 6′ girth) as heavily as possible on a 30-year felling cycle, with regular annual area coupes. The I class trees were enumerated and the number of such trees to be removed annually was fixed. We call these selection fellings nowadays and Troup has referred to them as Exploitation fellings.

(*b*). Thinning out the smaller girth classes to reduce their congested state, so that the II and III class trees might develop into I class trees under the most favourable conditions. This is roughly what Recknagel calls the "Indian System," and for extensive *sal* forests in the U. P. these proposals of Colonel Pearson formed the basis of management for the next 40 years. It was not a sylvicultural system in the true sense, since it made no attempt to guarantee normal regeneration and increment, normal distribution of the age classes, or to lead up to the normal forest, which was an impossible ideal in the early stages of management. But at least it guaranteed a sustained, and in fact steadily increasing, yield of mature timber, and the general improvement of the whole forest. In passing it may be noted that Colonel Pearson regarded one lakh of cubic feet of *sal* timber per annum as a safe estimate of outturn from the selection fellings over this tract. The actual total outturn of *sal* timber from this same tract last year amounted to 12 lakhs of cubic feet.

3. While Colonel Pearson's proposals were being adopted for most of the *sal* forests where the chief object of management was the production of large timber, other proposals were being made in the forests of Oudh. Reference must be made to Amery's proposals in 1874-75 for Gorakhpur. At that time *sal* in Gorakhpur was regarded much as we now regard *rohini* (*Mallotus philippinensis*), *i.e.*, as a worthless weed and a confounded nuisance. Proposals were drawn up for

the Ramgarh block to clear-fell the *sal* and replace it artificially with more valuable species, teak, *sissu* and *Eucalyptus* being tried. The first year's coupe was felled and there is a pathetic note 10 years later that the cost of cutting back and trying to eradicate the *sal* annually in this plantation was becoming prohibitive, and it would be advisable to abandon the plantation as a failure. This particular plot is now the best stocked and most even-aged young *sal* pole crop in the province! Thus the first introduction of the system of clear-felling *sal* in the U. P. ended in complete failure, (to be reintroduced 40 years later as a complete success).

4. For many years no particular method of management appears to have been adopted in the Oudh *sal* forests, but about 1890—95 we find the gradual adoption of coppice-with-standards in areas where small poles were in demand, and " Improvement fellings " elsewhere, with " Selection-cum-Improvement fellings " in the best forests such as North Kheri.

5. These methods of exploitation (we cannot call them sylvicultural systems) continued until about 1914, and then the second phase in the management of our *sal* forests commenced, and during the next dozen years nearly all the U. P. *sal* forests of the plains, *tarai* and *bhabar*, were brought under definite systems of management that aimed primarily at getting normal regeneration, normal distribution of the age classes, and in time the normal forest. Troup was a powerful factor in the change of outlook, and influenced largely by his writings, a clear-felling system was introduced in Gorakhpur by Marriott, while Collier in Haldwani and Howard in Ramnagar were the pioneers in the introduction of the Conversion-to-Uniform system. Between 1920 and 1927 some variant of the Periodic Block system with natural regeneration was introduced into almost every *sal* division in the Province. The only important exceptions were the hill forests of the Western Circle and the xerophitic *sal* areas of Jaspur and Saharanpur, and in these the old " Selection-cum-Improvement " or simple " Improvement " fellings continued.

6. In North Kheri however an attempt was made to introduce regular Selection *system* (as opposed to mere selection fellings), by

fixing a volume yield, calculated on complete enumerations and one of Von Mantel's modifications. (For a description of this system, see an article by the writer in the *Indian Forester*, August 1920.) The nett result of 10 years working of this system is that the forest is more uniform and less like a selection forest than it was originally! The reason for this result is fairly evident. The forests originally contained an excess of young middle-aged crops 8″—12″ diameter, the existence of which had their due influence on increasing the calculated volume yield, and the *true* selection system would have required the sacrifice involved in removing the surplus of these immature crops. It was perfectly natural, however, that no marking officer and no D. F. O. was going to use up more than he could help of his volume yield in cutting out healthy young crops of considerable potential but no immediate value, and an undue proportion of the total volume yield was therefore obtained from the large trees, thereby tending to reduce the larger diameter classes too rapidly, and automatically increasing the original abnormal distribution and proportion of regular even-aged young forest. This North Kheri working plan is an excellent illustration of the difficulties of attempting to apply the true Selection system of Europe to Indian conditions. It also illustrates the difficulty of applying a volume yield, based on a formula designed for a normal forest, to abnormal conditions. But the difficulties involved in a volume yield are by no means limited to this plan. Most of the P. B. I. yields of *sal* working plans of the last 10 years have been fixed by volume, and illustrate the trap that a volume yield can be when the necessary corollary of normal regeneration cannot be guaranteed. We have become rather shy of volume yields for *sal* forests in consequence.

7. I should like to emphasise that Troup was perfectly right to urge, and the working plan officers to attempt, the introduction of a definite silvicultural system in place of the "Selection-cum-Improvement fellings" that had become almost stereotyped in U. P. *sal* working plans. These attempts have taught us a great deal about *sal* silviculture and regeneration, and above all have indicated to us where we canexpect to succeed with a definite system, involving

the attainment of normal regeneration, and where we are likely to fail. This is a tremendous advance on the general attitude of the first phase, when no one knew or cared whether normal regeneration and the normal forest was being produced or not. The fact that a number of these attempts have failed does not detract from the merit of having made the attempt.

8. The system of strip fellings advocated by Hole never actually got beyond the experimental stage ; forest officers in the U. P. never clearly realised that Hole's method of natural regeneration in strips involved careful attention to three distinct and equally important factors, *i.e.*—

(*a*) manipulation of light (in strips),

(*b*) protection from competing weeds (by intensive rains weeding),

(*c*) protection from browsing (by fences).

As the experiments carried out attended to (*a*) only, and ignored (*b*) and (*c*), the resulting failures were quoted in condemnation of the system instead of the mistaken method of its application. (Incidentally *taungya* plantations give (*b*) and (*c*) and show that strip fellings are not essential to success).

9. A third phase in the management of our *sal* forests has now commenced. As explained above, the first phase was to apply Selection and/or Improvement fellings, but no silvicultural system, to all the *sal* forests, whether they were suitable for a proper system or not. The second phase was to adopt a system,—aiming ultimately at the theoretically normal forest,—for every forest whether we knew how to succeed in working it or not. In the present (third) phase, we start by distinguishing between (A) areas which we can guarantee to regenerate successfully either naturally or artificially, and (B) areas which we cannot guarantee to regenerate when and where we wish.

For A areas we can prescribe any silvicultural system we like, and are free to choose the one most suitable for the local conditions. For B areas, *the fact has to be faced that as we are not able to guarantee normal regeneration, no scientific silvicultural system can possibly be applied, and any attempt to introduce one is sooner or later bound to*

break down, just as the Periodic Block system is breaking down in many areas at present.

10. In A areas we include only the following types—

(*i*) where natural regeneration from coppice (*e.g.*, Gorakhpur) or existing advance growth (*e.g.*, Dehra Dun) is certain ;

(*ii*) where artificial regeneration by *taungya* or otherwise will be possible and *immediately* successful.

In such areas, the system of management is quite simple, *i.e.*, clear-felling (with possibly a temporary frost protection left where necessary). The annual regeneration coupe is fixed on the formula :—

$\frac{\textit{total area of working circle}}{\textit{rotation}}$; the coupes for the period of the working plan are chosen, and the rest of the forest worked over with thinnings. This is a definite and simple system which aims at producing a normal forest in one rotation.

11. The problem of the B type of *sal* areas is however very different. Here clear-felling is out of the question, the Periodic Block system has been extensively tried and failed, the true Selection system of Europe is the most difficult of all the systems to apply correctly in practice, and would obviously be inapplicable to these extensive forests. In fact, as indicated already, until we learn how to control the regeneration successfully, no real sylvicultural system is possible, and we have evolved no practical alternative to the proposals first formulated by Colonel Pearson 60 years ago. The only material modification is that in place of a 30-year felling cycle and removal of all trees of and over the exploitable diameter, we now adopt a 15 or 20-year felling cycle and aim at removing $\frac{1}{2}$ or $\frac{2}{3}$ of the exploitable trees. For want of a better term we call this operation " Selection fellings" (*not* Selection system), which are supplemented by " thinnings" in the smaller diameter classes.

12. A general definition and description of any " Selection Working Circle " has been drafted for inclusion in working plans which is quoted below :—

" In a Selection Working Circle, the chief object of management may be briefly defined as THE MAXIMUM SUSTAINED YIELD OF

TIMBER OF THE EXPLOITABLE DIAMETER. To obtain this object of management, two distinct operations are involved—

(1) to preserve or nurse up all trees under the exploitable diameter which may be expected to reach that diameter under the best conditions for growth ;

(2) to utilise all trees as soon as they reach the exploitable diameter, so far as sylviculture and sustained yield permit.

For practical purposes we may regard thinnings as concerned only with the first operation (*i.e.*, with trees below the exploitable diameter) and Selection fellings as concerned only with the second operation (*i.e.*, with trees of and above the exploitable diameter). Under Selection fellings, therefore, the object of management requires that every tree of and over the exploitable diameter (subject to any numerical limitation fixed in the working plan) should be marked unless there is a definite sylvicultural reason for its retention. Similarly under thinnings the object of management requires that every tree is left unless its removal will improve the timber producing capacity of the crop in terms of value.

(*Explanatory note.*—This definition of thinnings permits the removal—

(*i*) of trees with a negative increment, *e.g.*, dead, dying or rotting ;

(*ii*) thinning of congested crops ;

(*iii*) removal of species or stems of low value in favour of more valuable or better groups. It does *not* permit the removal of healthy but badly shaped stems solely because they are badly shaped)."

This definition applies to all *sal* forests where we cannot guarantee normal regeneration, which is why no reference is made to obtaining regeneration, or to the ultimate production of a normal forest—an ideal which we do not know how to get.

13. It may be regarded as a retrograde step to give up a sylvicultural system for a method of working which is not a system, but

at present we see no alternative, and further there are two very definite mitigating influences at work.

In the first place we know that in the U. P. *sal* forests as a whole there is an excess of the middle-aged classes, resulting from the flood of regeneration that sprang up in the 1870—90 period when adequate protection was first introduced. The existence of this must inevitably tend towards an increase of yield and revenue as these crops approach maturity, so that the probable result of management several decades hence will be not a sustained yield but an increasing yield of large timber. This is at any rate satisfactory compensation for postponing the commencement of the normal forest to a time when it will not involve the sacrifice of immature crops in excess of the normal.

In the second place, although at the moment large areas of *sal* forests are being thrown out of the Periodic Block system to "Selection fellings and thinnings" yet simultaneously every effort is being made by the territorial staff to develop large scale artificial regeneration by *taungya* or otherwise, and thereby enable the Working Plan branch in due course to retransfer areas from the B to the A category and again introduce a silvicultural system. Already, thanks to the enthusiasm and keenness displayed, we have good grounds for hoping that we may be on the edge of important developments. Thus for example in the Gonda Division, the new working plan has allotted practically *all* forests (both *sal* and miscellaneous) situated on ground fit for cultivation to a system of clear-felling and regeneration mainly by *taungya*. All the Gorakhpur forests have been in category A (normal regeneration guaranteed) for some time past. In the *sal* forests of Bahraich, Kheri, and the Western Circle generally, although the important developments in hand do not at the moment justify a working plan being based on them they do necessitate legislating for possible expansion in the near future, for once *taungya* really catches on, it seems to develop with remarkable rapidity.

14. The tendency in the most recent working plans is to encourage the expansion of artificial regeneration in a simple manner and the new North Kheri working plan may be quoted as a concrete example. The bulk of the *sal* forests are to be managed under "Selection fell-

ings and thinnings " on a 20-year felling cycle. But 1,000 acres of forest—a failed P. B. I of the old plan—have been left out of the Selection Working Circle and reserved for the D. F. O. to regenerate artificially as best he can. The only working plan provision is that the D. F. O. can fell an area up to 100 acres per annum, provided its immediate regeneration is guaranteed. If he cannot meet this guarantee, fellings will not be made, and these 1,000 acres will carry on very much as at present. If on the other hand he can, he has the pleasure of adding about half a lakh of rupees to his annual revenue, a sufficient inducement for his best endeavours. No question of over-felling can arise with such a proviso, so long as the maximum area that may be felled annually is a relatively small fraction of the normal area that should be regenerated annually in the whole Selection Working Circle. (In the North Kheri plan it is less than 1/7th).

15. Summarising the present tendency in U. P. *sal* working plans, there is a strong revulsion of feeling against any silvicultural system which involves inducing new (seedling) regeneration with a long regeneration period, and instead we encourage and aim at clear-felling and immediate regeneration as far as possible, and where this is not at present possible, we shelve all deliberate attempts at inducing new regeneration, and concentrate on nursing up the growing stock we already have on the ground to maturity, and utilise it when mature as fast as a sustained yield of mature timber permits. Fortunately in the extensive hill *sal* forests of the Western Circle where *taungya* or artificial regeneration will probably never be possible, quantities of *sal* regeneration still continue to appear and develop naturally without any deliberate attempts on our part to induce it, so we have no anxiety about these areas. And in the *bhabar* and plains forests, it is evident that we are tending more and more to the Bengal system of management rather than to the only apparent alternative, namely a period of destruction and fire followed by protection, which Colonel Pearson and the early pioneers found efficacious 60 years ago, and Assam and Nepal find equally efficacious to-day. The *via media* which we have followed patiently for the past 15 years now appears to be a blind alley, which leads nowhere. This much we may at

least justifiably claim, that our present forest management of the third phase follows our knowledge (such as it is) of *sal* sylviculture more closely than heretofore, and equally avoids the Scylla of ignoring what knowledge we possess, as in the first phase, and the Charybdis of assuming a knowledge we do not possess, as in the second phase. What the future will show lies on the lap of the Gods.

[In view of Mr. Smythies' article it is interesting to know that the Central Sylviculturist is shortly to make an extensive tour in all the *sal* provinces, namely United Provinces, Bihar and Orissa, Central Provinces, Bengal, Assam and Madras, with the express purpose of correlating the experimental work now being done on *sal* in these different areas. A representative officer from each province is to tour with him in the adjoining provinces as well as in his own area: by this means it is hoped that all our best sylviculturists' local knowledge will be shared by their neighbours to the advantage of all.—**Ed.**]

AIR-SURVEY OF FORESTS.

BY F. W. CHAMPION, I.F.S.

(1). In many of the more progressive countries of the world aeroplanes are being more and more largely used for making aerial surveys of forested and cultivated areas. The Burma Forest Department early realised the great value of such surveys for some of their vast forests, which, owing to their swampy nature and the absence of communications, are often extremely difficult and very expensive to survey from the ground. The first air survey of forests in the Indian Empire was therefore made in 1924, at the request of the Burma Government, by a party led by Mr. Kemp, with the assistance of two forest officers, Messrs. C. W. Scott, D. F. C., and C. R. Robbins, M.C., D. F. C., both of whom had served with the Royal Air Force during the War. About 1,400 square miles of the Irrawaddy Delta forests were surveyed, at a cost of about Rs. 300/- per square mile as against an estimate of Rs. 500/- per square mile for ground survey, and the results of the work were incorporated in Burma Forest Bulletin No. 11 of 1925, entitled "Aero-photo Survey and Mapping of the Forests

of the Irrawaddy Delta." This bulletin is so exhaustive and so well illustrated that it must remain as a text-book for all future surveys that may be undertaken, and it is with extreme diffidence that I am venturing to write on a subject of which I have so little experience or knowledge. The position, however, is this. The Irrawaddy Delta survey dealt only with absolutely flat country, with a profusion of large rivers, which made conditions almost ideal for aerial survey, and the forest surveyed contained large blocks of gregarious species such as *kanazo* (*Heritiera minor*). This survey, therefore, excellent though the results have proved to be, dealt with somewhat limited conditions of forest and country and did not make it quite clear how far such aerial surveying could be successfully applied to the more common types of forests occurring in the plains and hills of India and Burma generally.

(2). Mr. Canning has always been a great enthusiast for maps, and, learning that an aerial survey of some parts of Oudh was being undertaken in 1931 for settlement purposes, he seized the opportunity to arrange for some portions of the reserved plains forests of Oudh, which march with the cultivated areas, to be included in the aerial survey. This was done in parts of Pilibhit and Kheri Divisions in which working plan revisions happened to be going on at the same time, and this note deals with the results of that survey as compared with the results of the famous Irrawaddy Delta survey.

(3). The work was undertaken by the Indian Air Survey and Transport Company, Limited, of London and Rangoon, and the actual photography was done in February 1931. The cost was about Rs. 2,000/- for some 30 to 40 square miles of forest surveyed, or roughly about Rs. 55/- per square mile. These costs, however, were on the low side, as the survey done was only a trial, carried out at the same time as the real business of Settlement Survey, for which the organisation had already been perfected. The company's estimate for a special survey, including the photography and supply of mosaics to a scale of approximately 4″ to the mile, was from Rs. 55/- to Rs. 75/- per square mile, depending upon the compactness of the area to be surveyed and the distance from an already-existing base.

(4). The areas included in the photographs produced are of two types :—

(*a*) Low lying alluvial forests, understocked and interspersed with areas of pure grass land. The forests are mixed and consist of numerous species, the chief of which are ***khair*** (*Acacia catechu*), *shisham* (*Dalbergia sissoo*), *semal* (*Bombax malabaricum*), *haldu* (*Adina cordifolia*) *jamun* (*Eugenia jambolana*), and *gular* (*Ficus glomerata*), with some 20 or 30 other species in smaller proportions and generally by isolated trees. These forests are in the North Kheri Forest Division.

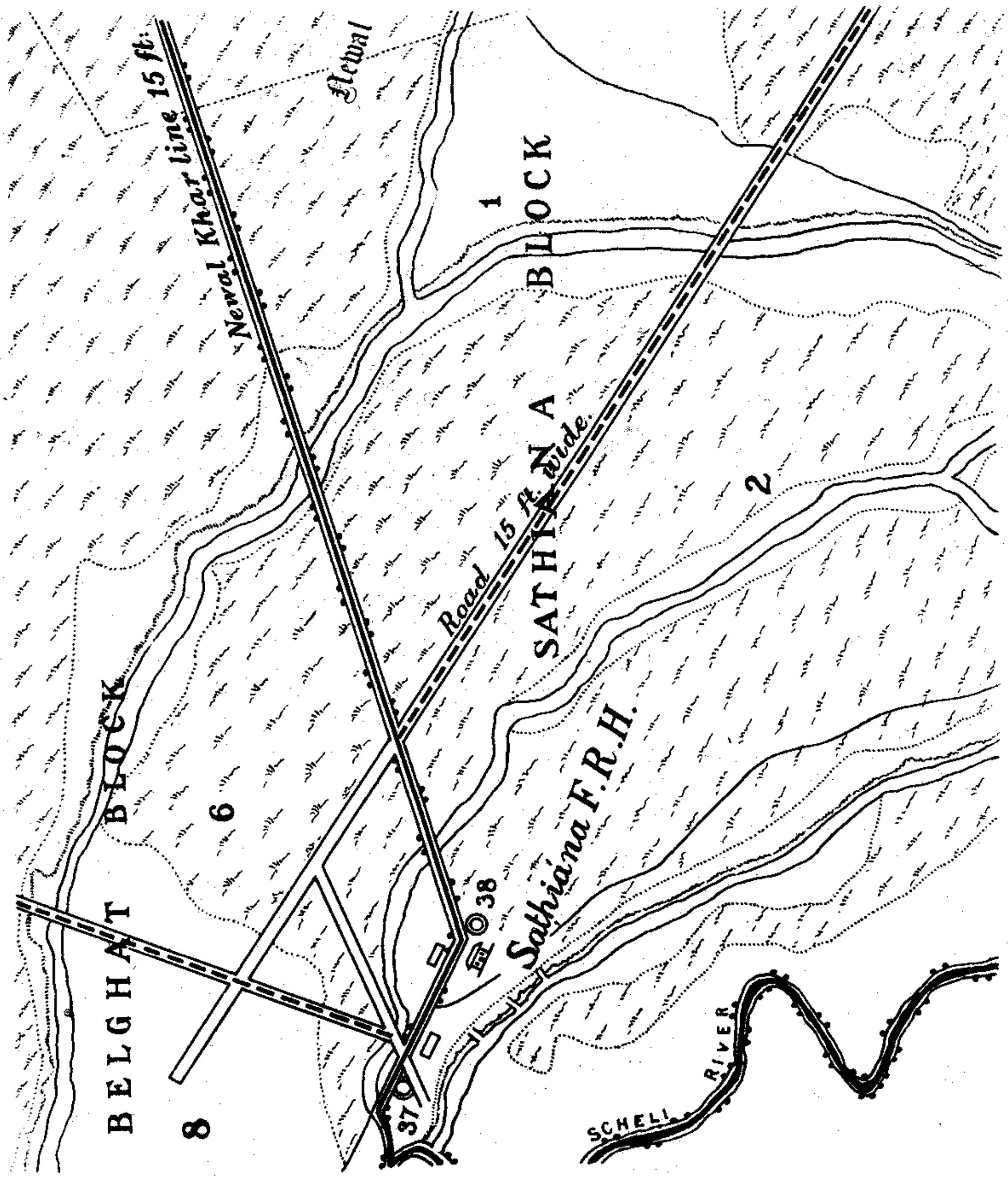
(*b*) More or less pure *sal* (*Shorea robusta*) forests, interspersed with blanks of various sizes, known locally as *chandars*. These forests are chiefly in Pilibhit Forest Division.

(5). Plates 1, 3 and 4 show typical results produced in the miscellaneous alluvial forests, a few details having been inked in to make the photographs clearer :—

Plate 1.—This photograph (and also plates 3 and 4), shows the exact positions of every patch of forest, and, indeed, on a larger scale enlargement, the position of almost every tree. The trees of different sizes, shades, and shapes are fairly easily distinguishable, and it is possible that, by comparison with a ground stock-map made to show every tree of some selected portion, which it is intended to have made next working season, it may prove possible to prepare a key by which the more important species at any rate may become identifiable. The straight white lines show the positions of the roads very clearly and accurately, the double white line on the left upper corner being a parallel motor and cart road. A rest-house (Sathiana) buildings and compound are clearly shown in the left centre and the exact course of the Soheli river is apparent in the left lower corner. The curious streaky effect in the upper right-hand corner is due to grass-land which has been burnt only in patches. *Plantation and water-courses* are also quite clear.

Plate 2.—This plate is a reproduction of the same piece of forest as shown in Plate 1, according to the old Forest Ground Survey of 1893—97.

N. Kheri Division.



The same area as Plate I. according to the ground survey of 1893—98.

Plate 3.—In this plate the dense block of forest in the upper right portion is nearly pure *sal* forest, with a steep drop of about 30′ in level near the outer fringe, and called locally a *damar*. The edge of the forested portion is bordered with *jamun* (*Eugenia jambolana*) on the lower level and there is also a narrow stream at the base of this *damar*. Neither this narrow stream, nor the drop in level, nor the *jamun* fringe is clearly indicated in the photograph. Nor can one or two internal narrow streams and roads be made out. In the lower right corner the boundaries of some rather unsuccessful plantations, which have not been burnt with the adjoining grass, are clearly shown. The left centre shows a belt of mixed miscellaneous forest interspersed with ponds. The extreme left of the photograph is blurred.

Plate 4.—This plate shows how clearly the course of a stream is shown and how the miscellaneous forest is now confined very largely to the neighbourhood of that stream.

Plate 5.—This plate shows an area of dense *sal* forest in Pilibhit Forest Division, with an area under regeneration fellings in the left centre. The famous frosty *chandars* are shown in the right lower centre. Roads would have shown more clearly if they had been cleaned up a little before the air-survey.

Plate 6.—This plate shows the dense *sal* forest of Pilibhit Division where it borders on cultivation. Each individual field in the cultivation is very clearly shown, much more so with a larger-scale enlargement.

(6). The following gives an idea of the value of the photographs as a whole :—

A. General.

(*a*) Such photographs would form an invaluable aid to a working plan officer and a complete set for this or any other division would enable the old 4″ ground survey, which is now very much out of date, to be corrected and amended much more accurately and at a fraction of the cost of a new ground survey.

(*b*). Such photographs would assist stock-mapping to a considerable extent. Blanks could be marked off at once; areas under regeneration fellings are generally visible; and it is possible that further

study and better photographs resulting from the use of specially selected photographic light filters may enable at least the more important species to be picked out even in mixed forest.

(*c*). Any such air-survey would have, of course, to be done in conjunction with a ground survey made by an experienced forest officer.

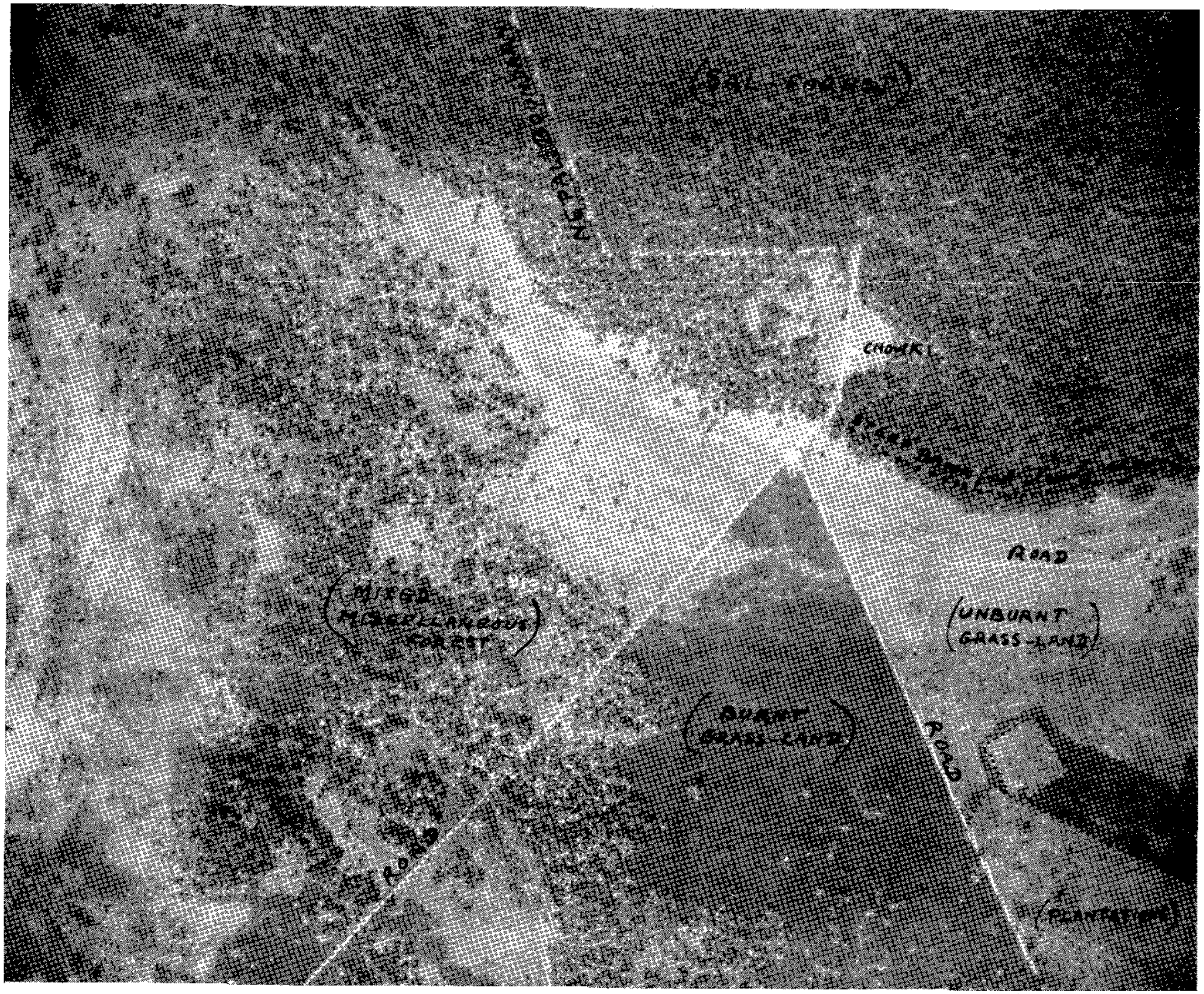
(*d*). Air photographs of hill forests would almost certainly not be so satisfactory as in the case of the plains forests, owing to the difficulty of differentiating heights, contours, etc., in a flat photograph of hilly country taken vertically. Oblique photographs would be of considerable assistance in such cases.

B. Photographic.

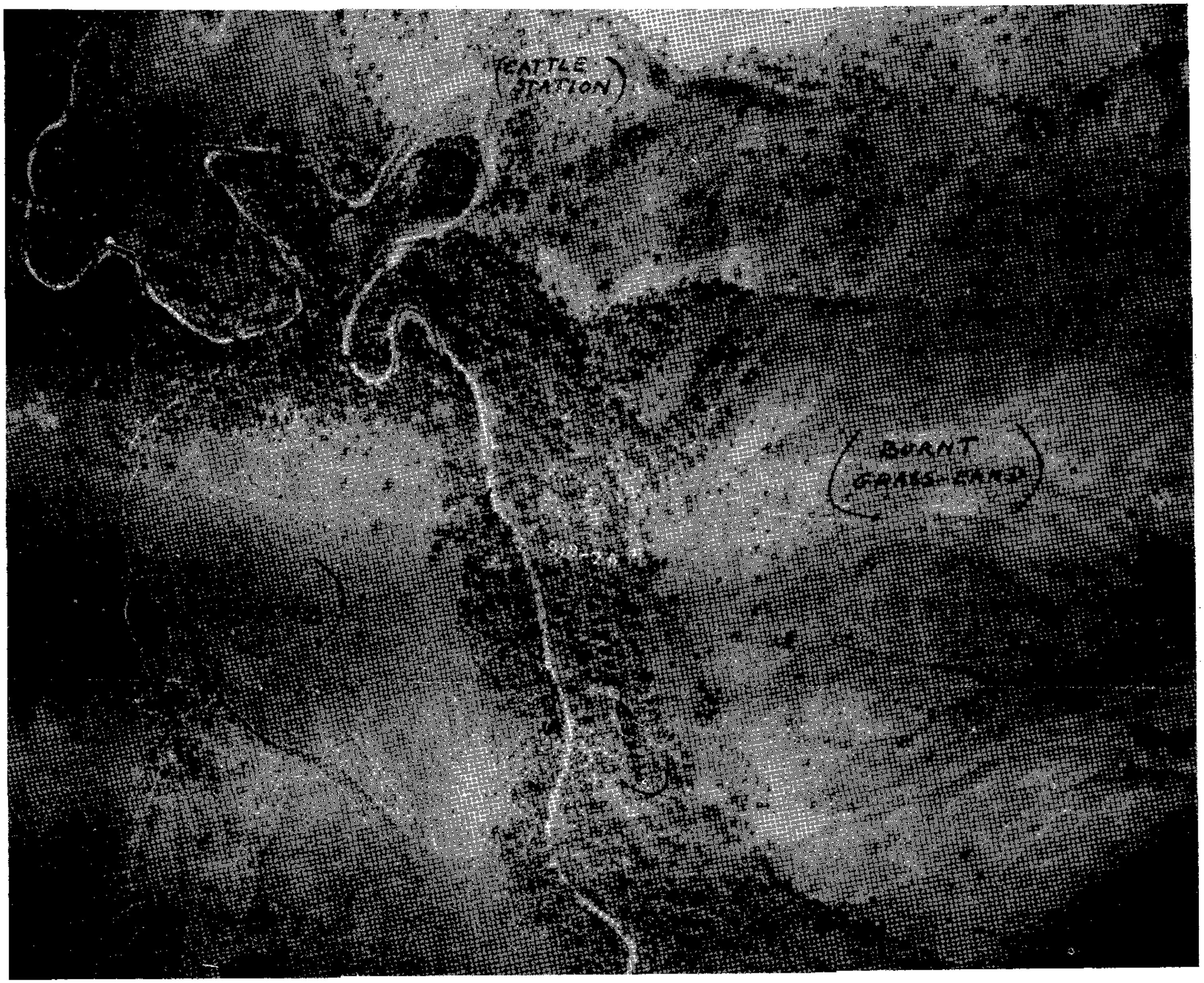
(*a*). The present set of photographs even though taken on panchromatic films, does not show various shades of green so clearly as could be desired. The Company could probably improve on the present results if they would experiment with various types of photographic light filters specially designed for separating various shades of green. Specially selected printing papers would also improve the results.

(*b*). The set of photographs grades from excellent to poor, and any contract given should insist upon a uniform grade of photographs. Poor results, due generally to unsatisfactory flying conditions on the particular day they were taken, should be replaced by fresh photographs.

(*c*). The time of taking the photographs should be carefully chosen. Leafless trees do not show properly in a photograph, and advantage should be taken of the seasons in which special tints in the foliage, or striking flowers are conspicuous. Probably February to March is the best time in the United Provinces, since most trees are then showing various tints, few have dropped their leaves entirely, and atmospheric conditions are excellent for flying. The burning of grass-lands inside the forests at that time is, however, rather a drawback, unless the work has been entirely completed. Clouds of smoke or partially burnt patches tend to spoil photographs in some cases, particularly oblique photographs.



N. Kheri



N. Kheri.

(*d*). Photographs taken in the morning or evening are probably better than those taken at mid-day with a high sun and poor shadows.

(*e*). *Just before such air-survey work is undertaken, boundary* pillars—every fifth pillar or essential corner pillars—should be clearly *defined by putting lime on the ground near the pillar.* Such lime should be arranged in a square or a cross rather than a circle, because photographic blemishes tend to show as white circles and are liable to be confused with boundary pillars.

(*f*). Internal roads, *nalas*, small streams, etc., which it is desired to be shown in the survey, should be cleared of side-branches and undergrowth just before the air-survey is made, so as to make them stand out clearly in the photographs.

Subsequent map work.—

(7). The photographs produced in this trial survey are a mosaic reduced to an approximately 4″ to the mile scale, with loose contact prints on a 6″ scale for further examination of detail. It would appear from correspondence with the Company that it is very difficult to make a really accurate mosaic-map to an exact scale owing to the following reasons :—

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(*a*) Use the present 4″ ground survey map as a basis.

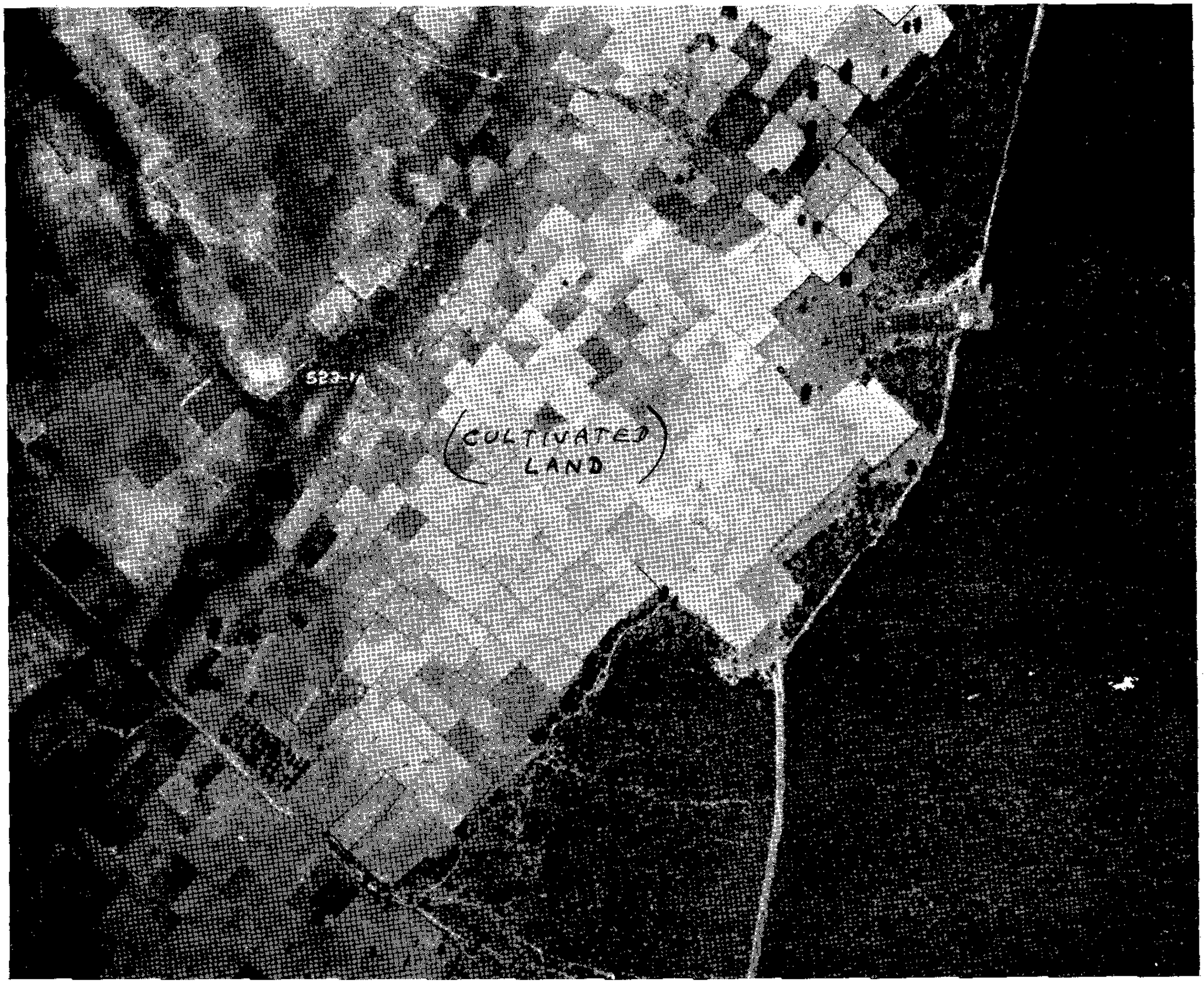
(*b*) Make up a mosaic of aerial survey photographs, preferably on a scale as near 4″ to the mile as possible.

(*c*) Ink in all necessary details on this mosaic. It is very important that the mosaic be made on a photographic paper which is not too glossy, or this inking will become very difficult. A variety of bromide paper called "satin" gives nearly as much detail as glossy paper and is probably the best for the purpose. Any doubtful points should be examined with the help of larger scale enlargements of the portion concerned.

(*d*) Having inked in the mosaic to the extent required, all forest details which it is intended to utilise should be plotted on to the existing 4″ ground survey maps, in which corrections, such as changes in watercourses, new roads, etc., should also be made at the same time. New printing blocks should then be made from these amended and corrected old 4″ survey sheets, and as many copies as required could then be re-printed.

(*e*) In this way it would be possible to prepare new 4″ maps, showing corrected topographical features, and also some at least of the forest features required for stock-mapping or other purposes, far more accurately, quickly, and economically than any other form of forest survey yet undertaken

Pilibhit Forest Division.


523-A
CULTIVATED
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(*f*) Before undertaking such an aerial survey, some selected forest officer with a knowledge of photography should if possible be given a short course in such work, if arrangements with the Royal Air Force for such a course could be made.

(9). In order to compare the impressions of the writer, as given above, of the value of such a survey, the following abridged summary of the results of the Irrawaddy Survey, as written by Mr. Robbins and printed on pages 41 and 42 of Burma Forest Bulletin No. 11 of 1925 may be of interest. The writer has made notes against some of Mr. Robbins conclusions, where his ideas show some marked difference :—

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(*d*) Comparison of photographs with the ground from the air is a great help to their interpretation.

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(*g*) A series of oblique photographs taken from heights of 1,500—3,000 feet is of great assistance in interpreting the results of vertical photographs.

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(10). As regards the contract for such a survey reference should be made to the contract used for the Irrawaddy Delta Air Survey, which is printed on page 28 of Burma Forest Bulletin No. 11 of 1925. The Indian Air Survey and Transport Company, Limited, quote a rate of Rs. 300/- per hour including the time taken to and from the aerodrome for a machine to be used for a preliminary reconnaissance of areas which it is intended to have surveyed. Mr. Robbins carried out such a reconnaissance in the Irrawaddy Delta at the rate of several hundred square miles per diem, but such a rate would not be possible for an untrained observer. As regards the actual aerial survey, a normal day's work consists of four hours' flying, and photography of 80 square

miles. The average plains division in the United Provinces could, therefore, be surveyed from the air in four days, as against perhaps a whole season required by an ordinary ground survey party!

(11). To summarise, there is no doubt whatever but that aerial survey, used in conjunction with the already existing ground survey, will prove a very valuable, expeditious, and cheap method of bringing the existing ground survey maps of plains forests up to date and of improving existing or making future stock-maps. At present it is doubtful how far such aerial survey will prove of value in greatly mixed plains forests or in mountain forests, but it is probable that further experience and research will ultimately overcome at least some of the difficulties at present encountered in the aerial survey of such areas. It is also doubtful how far such aerial survey can be utilised for preparing really accurate new maps (where old ones do not already exist) to an exact scale owing to the reasons already given in paragraph (7) of this note. It is to be noted, however, that the Indian Air Survey and Transport Company, Limited, prepare 16″ scale settlement maps, rectified to points fixed by ground survey, and they claim that their errors do not exeed 1/200 in such work. If this claim is justified, *and at least the settlement officers appear to be satisfied with the* work produced, there seems to be little to cavil at in the use of such aerial survey in the production of even new maps for forest purposes, where absolute accuracy is not really so important as in the case of the settlement of cultivated fields. An excellent summary of the present-day uses of air-survey for forest purposes is given by Mr. Robbins in the Empire Forestry Journal of 1929.

AIR-SURVEY OF FORESTS.

BY F. W. CHAMPION, I.F.S.

(1). In many of the more progressive countries of the world aeroplanes are being more and more largely used for making aerial surveys of forested and cultivated areas. The Burma Forest Department early realised the great value of such surveys for some of their vast forests, which, owing to their swampy nature and the absence of communications, are often extremely difficult and very expensive to survey from the ground. The first air survey of forests in the Indian Empire was therefore made in 1924, at the request of the Burma Government, by a party led by Mr. Kemp, with the assistance of two forest officers, Messrs. C. W. Scott, D. F. C., and C. R. Robbins, M.C., D. F. C., both of whom had served with the Royal Air Force during the War. About 1,400 square miles of the Irrawaddy Delta forests were surveyed, at a cost of about Rs. 300/- per square mile as against an estimate of Rs. 500/- per square mile for ground survey, and the results of the work were incorporated in Burma Forest Bulletin No. 11 of 1925, entitled "Aero-photo Survey and Mapping of the Forests

of the Irrawaddy Delta." This bulletin is so exhaustive and so well illustrated that it must remain as a text-book for all future surveys that may be undertaken, and it is with extreme diffidence that I am venturing to write on a subject of which I have so little experience or knowledge. The position, however, is this. The Irrawaddy Delta survey dealt only with absolutely flat country, with a profusion of large rivers, which made conditions almost ideal for aerial survey, and the forest surveyed contained large blocks of gregarious species such as *kanazo* (*Heritiera minor*). This survey, therefore, excellent though the results have proved to be, dealt with somewhat limited conditions of forest and country and did not make it quite clear how far such aerial surveying could be successfully applied to the more common types of forests occurring in the plains and hills of India and Burma generally.

(2). Mr. Canning has always been a great enthusiast for maps, and, learning that an aerial survey of some parts of Oudh was being undertaken in 1931 for settlement purposes, he seized the opportunity to arrange for some portions of the reserved plains forests of Oudh, which march with the cultivated areas, to be included in the aerial survey. This was done in parts of Pilibhit and Kheri Divisions in which working plan revisions happened to be going on at the same time, and this note deals with the results of that survey as compared with the results of the famous Irrawaddy Delta survey.

(3). The work was undertaken by the Indian Air Survey and Transport Company, Limited, of London and Rangoon, and the actual photography was done in February 1931. The cost was about Rs. 2,000/- for some 30 to 40 square miles of forest surveyed, or roughly about Rs. 55/- per square mile. These costs, however, were on the low side, as the survey done was only a trial, carried out at the same time as the real business of Settlement Survey, for which the organisation had already been perfected. The company's estimate for a special survey, including the photography and supply of mosaics to a scale of approximately 4″ to the mile, was from Rs. 55/- to Rs. 75/- per square mile, depending upon the compactness of the area to be surveyed and the distance from an already-existing base.

(4). The areas included in the photographs produced are of two types :—

(*a*) Low lying alluvial forests, understocked and interspersed with areas of pure grass land. The forests are mixed and consist of numerous species, the chief of which are ***khair*** (*Acacia catechu*), *shisham* (*Dalbergia sissoo*), *semal* (*Bombax malabaricum*), *haldu* (*Adina cordifolia*) *jamun* (*Eugenia jambolana*), and *gular* (*Ficus glomerata*), with some 20 or 30 other species in smaller proportions and generally by isolated trees. These forests are in the North Kheri Forest Division.

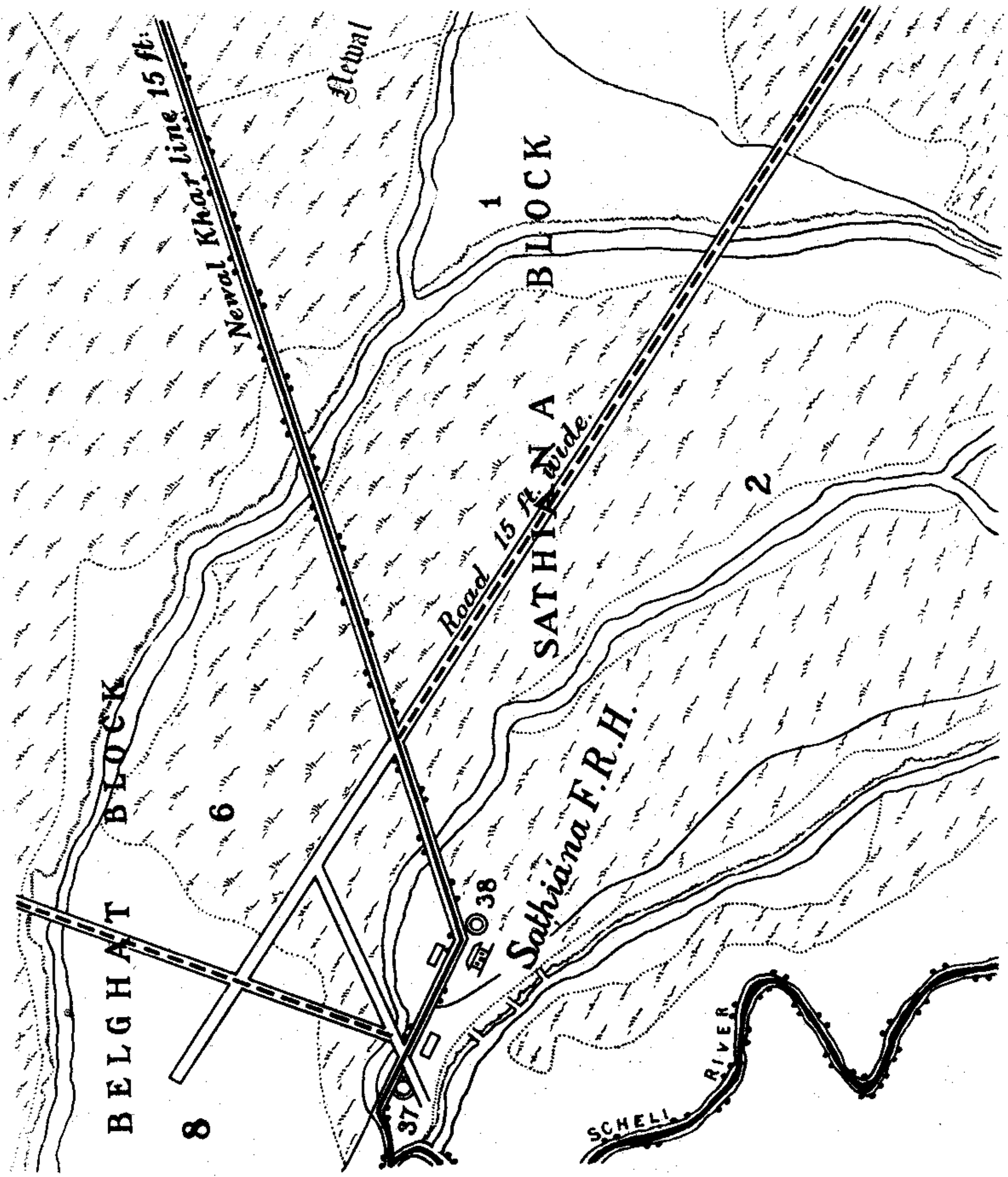
(*b*) More or less pure *sal* (*Shorea robusta*) forests, interspersed with blanks of various sizes, known locally as *chandars*. These forests are chiefly in Pilibhit Forest Division.

(5). Plates 1, 3 and 4 show typical results produced in the miscellaneous alluvial forests, a few details having been inked in to make the photographs clearer :—

Plate 1.—This photograph (and also plates 3 and 4), shows the exact positions of every patch of forest, and, indeed, on a larger scale enlargement, the position of almost every tree. The trees of different sizes, shades, and shapes are fairly easily distinguishable, and it is possible that, by comparison with a ground stock-map made to show every tree of some selected portion, which it is intended to have made next working season, it may prove possible to prepare a key by which the more important species at any rate may become identifiable. The straight white lines show the positions of the roads very clearly and accurately, the double white line on the left upper corner being a parallel motor and cart road. A rest-house (Sathiana) buildings and compound are clearly shown in the left centre and the exact course of the Soheli river is apparent in the left lower corner. The curious streaky effect in the upper right-hand corner is due to grass-land which has been burnt only in patches. *Plantation and water-courses* are also quite clear.

Plate 2.—This plate is a reproduction of the same piece of forest as shown in Plate 1, according to the old Forest Ground Survey of 1893—97.

N. Kheri Division.



The same area as Plate I. according to the ground survey of 1893—98.

Plate 3.—In this plate the dense block of forest in the upper right portion is nearly pure *sal* forest, with a steep drop of about 30′ in level near the outer fringe, and called locally a *damar*. The edge of the forested portion is bordered with *jamun* (*Eugenia jambolana*) on the lower level and there is also a narrow stream at the base of this *damar*. Neither this narrow stream, nor the drop in level, nor the *jamun* fringe is clearly indicated in the photograph. Nor can one or two internal narrow streams and roads be made out. In the lower right corner the boundaries of some rather unsuccessful plantations, which have not been burnt with the adjoining grass, are clearly shown. The left centre shows a belt of mixed miscellaneous forest interspersed with ponds. The extreme left of the photograph is blurred.

Plate 4.—This plate shows how clearly the course of a stream is shown and how the miscellaneous forest is now confined very largely to the neighbourhood of that stream.

Plate 5.—This plate shows an area of dense *sal* forest in Pilibhit Forest Division, with an area under regeneration fellings in the left centre. The famous frosty *chandars* are shown in the right lower centre. Roads would have shown more clearly if they had been cleaned up a little before the air-survey.

Plate 6.—This plate shows the dense *sal* forest of Pilibhit Division where it borders on cultivation. Each individual field in the cultivation is very clearly shown, much more so with a larger-scale enlargement.

(6). The following gives an idea of the value of the photographs as a whole :—

A. General.

(*a*) Such photographs would form an invaluable aid to a working plan officer and a complete set for this or any other division would enable the old 4″ ground survey, which is now very much out of date, to be corrected and amended much more accurately and at a fraction of the cost of a new ground survey.

(*b*). Such photographs would assist stock-mapping to a considerable extent. Blanks could be marked off at once; areas under regeneration fellings are generally visible; and it is possible that further

study and better photographs resulting from the use of specially selected photographic light filters may enable at least the more important species to be picked out even in mixed forest.

(*c*). Any such air-survey would have, of course, to be done in conjunction with a ground survey made by an experienced forest officer.

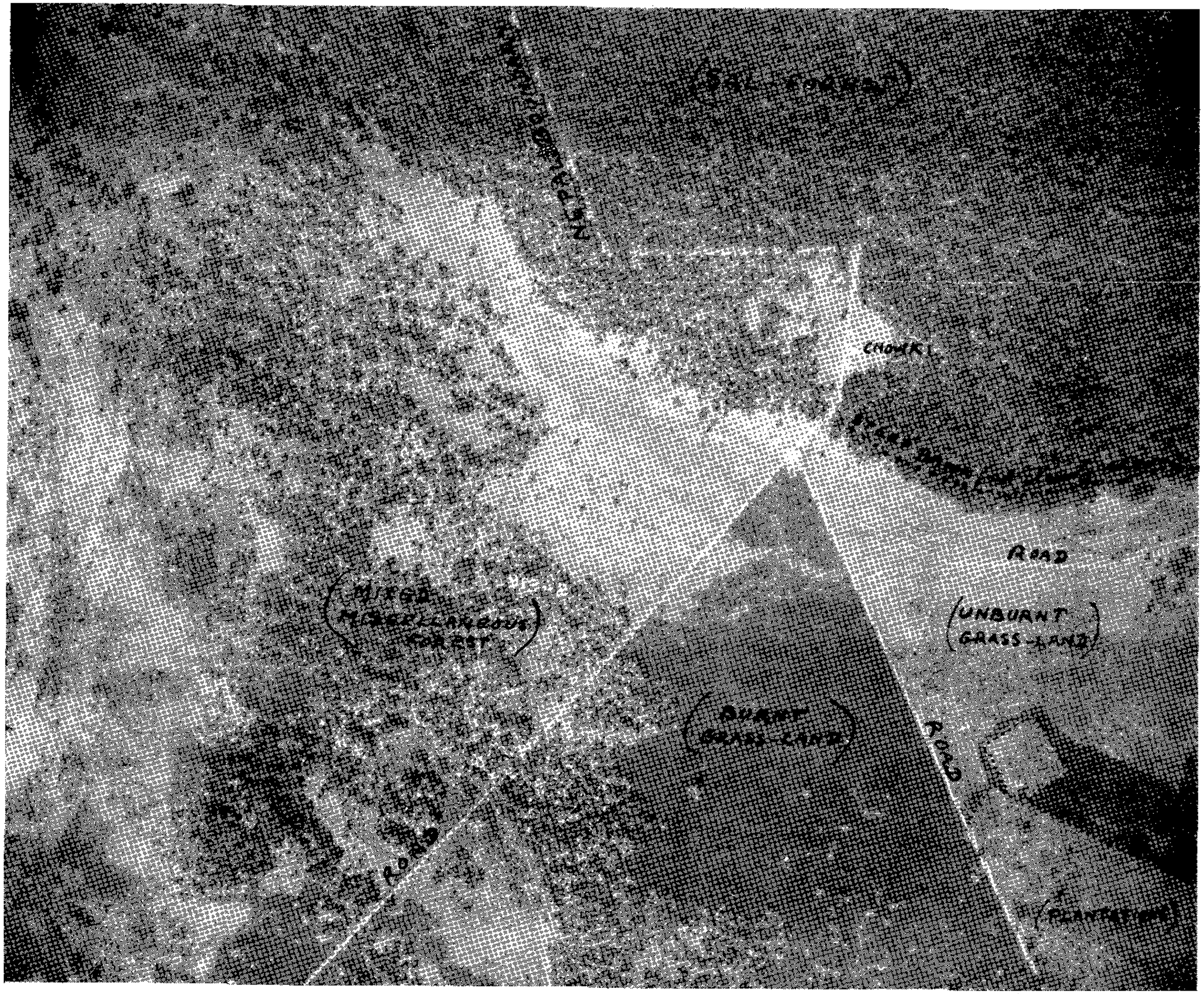
(*d*). Air photographs of hill forests would almost certainly not be so satisfactory as in the case of the plains forests, owing to the difficulty of differentiating heights, contours, etc., in a flat photograph of hilly country taken vertically. Oblique photographs would be of considerable assistance in such cases.

B. Photographic.

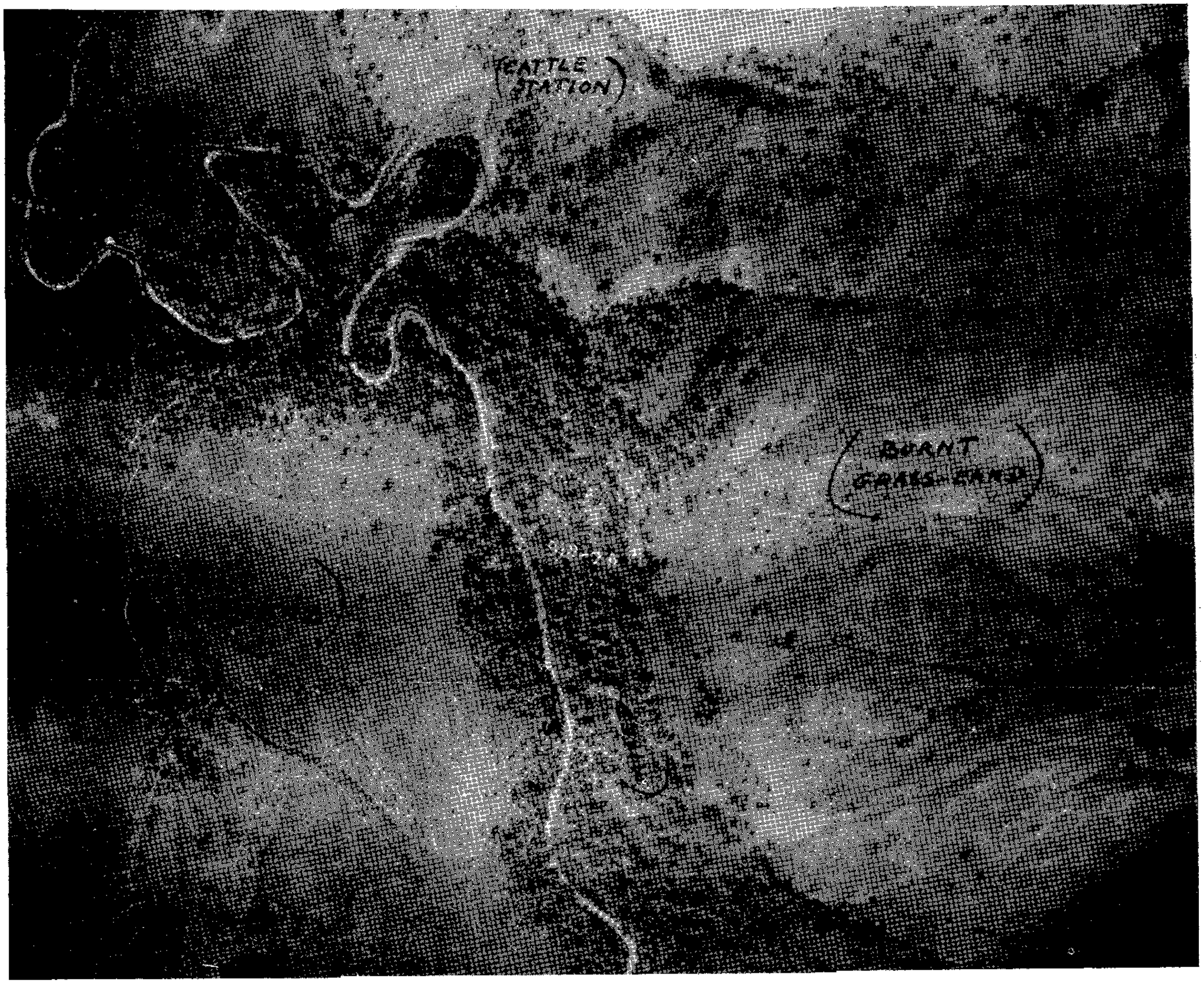
(*a*). The present set of photographs even though taken on panchromatic films, does not show various shades of green so clearly as could be desired. The Company could probably improve on the present results if they would experiment with various types of photographic light filters specially designed for separating various shades of green. Specially selected printing papers would also improve the results.

(*b*). The set of photographs grades from excellent to poor, and any contract given should insist upon a uniform grade of photographs. Poor results, due generally to unsatisfactory flying conditions on the particular day they were taken, should be replaced by fresh photographs.

(*c*). The time of taking the photographs should be carefully chosen. Leafless trees do not show properly in a photograph, and advantage should be taken of the seasons in which special tints in the foliage, or striking flowers are conspicuous. Probably February to March is the best time in the United Provinces, since most trees are then showing various tints, few have dropped their leaves entirely, and atmospheric conditions are excellent for flying. The burning of grass-lands inside the forests at that time is, however, rather a drawback, unless the work has been entirely completed. Clouds of smoke or partially burnt patches tend to spoil photographs in some cases, particularly oblique photographs.



N. Kheri



N. Kheri.

(*d*). Photographs taken in the morning or evening are probably better than those taken at mid-day with a high sun and poor shadows.

(*e*). *Just before such air-survey work is undertaken, boundary* pillars—every fifth pillar or essential corner pillars—should be clearly *defined by putting lime on the ground near the pillar.* Such lime should be arranged in a square or a cross rather than a circle, because photographic blemishes tend to show as white circles and are liable to be confused with boundary pillars.

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Subsequent map work.—

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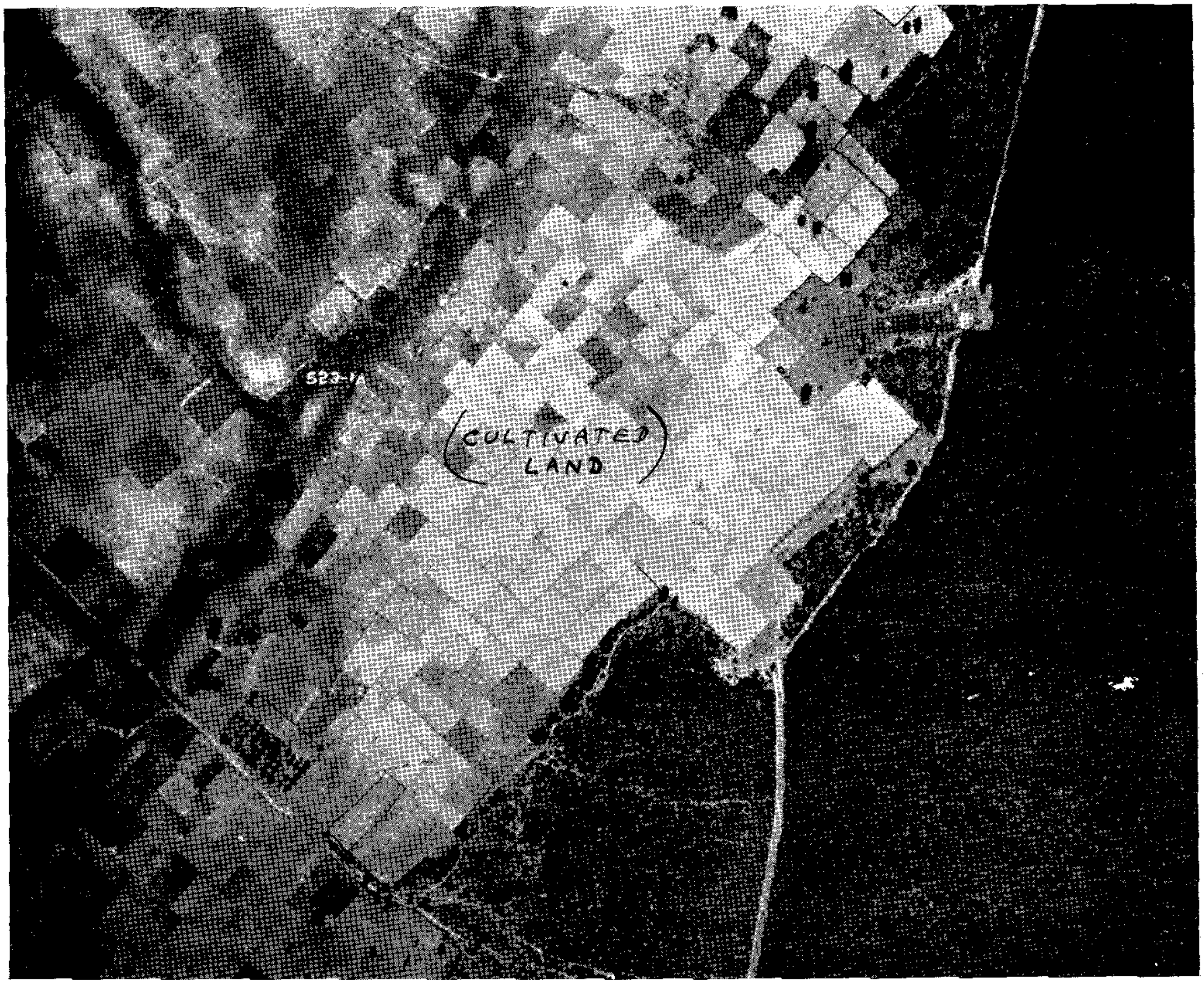
523-A
CULTIVATED
LAND

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DESTRUCTION OF TROUT IN THE TIRTHAN RIVER, KULU.

BY K. L. AGGARWAL, I.F.S.

There was an exceptionally heavy shower of rain for the two days on the 17th and 18th of July, 1932, which caused a cloud-burst in the upper reaches of the Tirthan valley of the Seraj Tehsil, Kulu, with the result that the stream came down in spate and there was an unusually heavy flood. The swift water of the swollen stream scooped out the bed of the stream in many places, and the banks now look much higher,

particularly near Bathad Civil Rest House where a dam was temporarily formed with the logs, etc., which had been washed down and the water rose almost to the bridge to a height of nearly 20 feet. The appearance of the stream at this place is very much changed. A large number of kail and fir trees near the bank have been washed down and the bed has widened out considerably. Big logs can still be seen heaped up in the stream at several places. The flood was so severe that three men sitting in a water-mill were taken so suddenly unawares that they were carried down and crushed to death.

Lower down at the confluence of the Tirthan and its tributary, the Jibi khad, at Banjar an expanse of water spread over a large area but here the valley opens out and hence the speed of the water slows down. The Tirthan of late had become quite a favourite with anglers because of the large quantities of trout, and Manglaur was quite an ideal place for fishing. With the heavy flood and on account of boulders and large quantities of sand and mud that were carried down the trout were choked to death, and as the water receded they were found scattered over the banks in the sand dead and dying and were removed by the surrounding villagers in basket loads. From all accounts it seems that the destruction of fish was enormous, and *kilta* loads were removed in hundreds all along the river below Bandal up to Larji over a distance of some 17 miles. It is said that for a couple of days there was an awful stench from the dead fish along the banks. It appears that mostly trout was killed and the local fish did not fare so badly. Since then the fishermen are reported not to have netted any trout at all. It seems that the Agricultural Department will have to do something and should not only close the stream entirely for a couple of years to trout fishing but should also restock it with fresh fish.

EUROPEAN SILVICULTURAL RESEARCH—PART IV.—MIXTURES.

BY H. G. CHAMPION, I.F.S.

In India, this question of the relative merits of more or less pure crops and crops with a mixture of species is constantly gaining in importance and has indeed come to be one of the chief silvicultural

problems of the country. It so happens, that even more than in Europe, single species tend so greatly to outdistance all their associates from the economic view point, that it is necessary to admit that a crop quality inferiority of even two quality classes as compared with potentialities with the associates is insufficient to equalise returns in the first rotation if financial prospects are alone considered. Thus do matters often stand for teak, *sal* and deodar with the result that the country is full of instances of these trees being raised on soils more suitable for other species. And it is further often true that only these highly priced timbers can cover costs of extraction and so alone are worth trouble and expense in raising.

Granting all this, we have now to deal with the questions of whether the poorer quality pure crops will ever maintain such early promise as they shew, whether they would not develop better and so be more paying if we had fewer or even the same number of stems in mixture with other species better suited to the locality in question, and whether we should aim at pure or mixed crops in those areas where one species is not of preponderating importance.

In this article, it is proposed to review the experimental work on mixed crops seen on the Continent and in Great Britain, with the prefatory remark that only a decidedly limited portion of the field was covered though one or two investigations discussed are of special value from their long standing, adequate scale and scientific execution.

I frequently attempted to collect records of specific instances proving the much advertised drawbacks and losses due to pure crops as such, and the results were most unsatisfactory. It seems certain that a great deal of the discredit is ascribable, not to purity of crops as such, but to mistakes in management, above all to planting up extensive areas with a species outside its natural distribution either as regards climate or soil, to planting on soils perhaps potentially suitable, but rendered unsuitable by undue exposure or other forms of faulty treatment, to using unsuitable strains of seed or planting stock, to failure from fungus or insect attack or whatever cause, to establish the new crop and soil cover quickly, and so on. This is particularly the case with pure spruce and though one would have

thought that a few suitably planned experiments could have given conclusive evidence, none such were traced. The soil peculiarities under certain pure crops, again notably for spruce, have of course been much studied and their drawbacks realised, but those drawbacks concern regeneration rather than increment which must be the primary consideration for the greater part of the life of a crop. The fact remains that general experience from widely scattered regions agrees that a pure spruce regime cannot maintain if even attain the high financial return formerly expected of it, but it must be remembered that the characteristics of spruce as regards root system, humus formation, density of canopy, etc., are exceptionally pronounced and largely peculiar to it, so that great caution is needed in arguing from past experience with pure spruce to future results with other species.

The other stock instance of pure oak is very instructive from recent work (not seen on the tour) demonstrating clearly enough that whatever the benefits conferred by a beech understory or intermixture in Central Europe, there may be none under different conditions, as for example with an oceanic climate, in fact the oak may suffer just as underplanting light demanders with spruce may result in detriment to the overwood.

The technique of raising mixed coniferous regeneration has been described almost *ad nauseam* and accounts can be read in any of the more modern text books and in countless articles in the periodicals. Examples were studied at Komatau and Salnau in Czecho Slovakia, in the famous Kelheim forests of Bavaria, and at Winterthur in Switzerland. In very general terms it may be said that this technique has usually been evolved from the general and special experience of individual territorial officers rather than from special intensive research in the narrower sense. In matters such as this, it is probable that no amount of precise knowledge will ever remove to any extent the need for experience in execution of the necessary regeneration operations and the most obvious field for research is the study of the underlying causes which should enable one to tackle the more difficult areas with greater success and certainty, and pave the way for further advance. As far as could be discovered, very little such work appears

to be in progress even into a problem which was obviously important in several places, *i.e.*, the question of minimum and optimum spacing out of the dense thickets of regeneration and the best stage at which to do it. This operation appeared to be neglected in some places, the explanation offered being lack of funds. Incidentally, it may be unorthodox, and ever unjustified and unfair, but the impression was obtained that some of the modern elaborations of silvicultural system and felling sequence derive not a little of the evidential support adduced in their favour from the fact that they have been developed in forests where regeneration is not particularly difficult so that the method of removing the old wood is not of primary importance. Admittedly the point was not specially investigated but enough was seen to remind one of the need for care in co-ordination of cause and effect in regeneration experiments,—it would not be difficult to illustrate the point with Indian examples.

With the successful solution of the problem of the regeneration of mixed species, the problem of the mixed crop is begun rather than ended, for most usually the greater difficulties lie in the subsequent tending. The relative rates of growth of the several species vary from the start and the minor differences in age consequent on regeneration technique cannot always be in the most desirable direction. Early tending can usually adjust the balance in such a way as to retain a proportion of a species which would otherwise tend to be smothered and lost, but it is in the sapling and small pole stage that a clear decision as to what is wanted and definite knowledge as to how to attain it are most urgently needed. Without this the stage is quickly passed at which the forester remains in control and afterwards his attempts to dictate how the crop shall develop are liable to be laughed at by Nature.

An interesting example of the far-reaching results of varied tending in the critical stages is to be seen in the Sihlwald of Zürich where a set of plots was laid out in 1906 in a mixed young pole crop of spruce, silver fir and beech. In one plot crown thinnings have been done periodically, in another C grade ordinary thinnings have been made, whilst the third was left to itself for comparison. The plots

are now totally different. The crown thinnings have given a coniferous overwood with the beech as an understory only occasionally contributing to the main canopy ; the ordinary thinning on the other hand has tended to eliminate the conifers and leave nearly pure beech ; the control occupies an intermediate position as regards proportions of the mixture, but naturally the trees are narrow crowned of small diameter and with less timber than either of the tended crops. It is obviously impossible to mark thinnings in such crops exclusively on tree and crown classes as there must be a personal decision between the broad leaved and coniferous tree, other things appearing equal, but these plots nevertheless illustrate what can be done without ever breaking the canopy.

At Zürich, also, in the Rehalp, are to be seen a trio of plots with beech and larch mixture. The larch in one plot was introduced in beech natural regeneration when the latter was four years old, a control plot of pure beech adjoining. In the third plot, pure larch was underplanted with beech when 40 years old. That the addition of the larch has enormously increased the value of the crop (nearly threefold is claimed) need not be questioned, but as there is no larch plot without beech, the contribution made to our knowledge of mixtures is, to say the least, but slight.

In the vicinity of Freiburg (Koeherhof) there is a series of afforestation plots dating back to about 1882, which is important in the present connection and well worth seeing. The land was an abandoned clearing on a flattish hill top with relatively little variation in soil and gradient so that aspect also does not exert a great effect. There are about 20 plots each with a different species, mixture, or regeneration method, and although there are no replications, closely similar plots are generally adjoining so that with the rather exceptionally uniform conditions, comparisons can be made with a fair degree of confidence. For assessment, the central parts of the plots have been used to avoid marginal effects. Strip mixtures are included, of oak with spruce and silver fir, the former having three years start in age and constant help in cleaning and thinning, but it has proved impossible to keep the oak free, particularly with the spruce, and pure oak would certainly

look better. Even with the two conifers together, it has been very difficult to keep the fir from suppression and it could only be retained *with sacrifice of crop volume and form. These 50 years old plots*, always specially cared for, provide an object lesson for India for experiments with mixtures and a warning against excessive confidence or optimism that any selected mixture will do what is expected or hoped of it even if early development is satisfactory.

The British afforestation investigations included several on mixtures, the usual lay out being a 5×5 plot chessboard, with 25 per cent. steps between the two pure cultures, *i.e.*, for species A and B, the steps have 100 per cent., 75 per cent., 50 per cent., 25 per cent., and 0 per cent. of A with the complementary percentage of B. The mixture is usually by single stems and as the work is all in the initial stages, tending difficulties have not yet been encountered. The criticism is valid that some of these mixtures are being tried without adequate prior knowledge of the silviculture and relative behaviour of the constituent species, but justification may be found in the need for the earliest possible solution before big scale afforestation is completed.

Some interesting and unusual methods are in progress in the Forest of Dean in an attempt to solve the special and varied difficulties encountered with pure oak. Experience having indicated that oak should be kept dense during its early years and that the unremunerative period is long compared with other species, the idea was developed that the oak might be restricted to closely spaced groups so distributed over the regeneration area as to close up in the later part of the rotation, the intervening ground being stocked with beech as soil improver and larch to give an early return. It is easy to criticise this and comparable experiments as over elaborate and too ambitious, trying three species mixture in a relatively complicated lay-out before proficiency can be claimed with two species mixtures in simple lay-out, but it takes a long time to get results and the sooner the work is started and the more thorough trials made, the sooner we shall acquire the required knowledge, and the preferable attitude is one of admiration and emulation of the courage displayed. For an account of the method of planting in dense groups spaced at wide intervals, Anderson's papers

in the Scottish Forestry Journal, 1930, and the Quarterly Journal of Forestry, 1931, should be read.

In several of the foregoing paragraphs, we have seen possible ways in which the experience of other countries may be helpful to India and it only remains to summarise for the subject of mixtures as a whole.

Those in charge of our important mixed coniferous forests of the W. Himalaya are aware of European developments and are adapting them to the local conditions and requirements, and it is hardly necessary to warn them against slavish adoption of latest fashions which need first to have withstood the fire of hostile criticism and proved their worth.

Both in the coniferous and broadleaved forests, it is evident that tending is the subject in which well-based knowledge is at once the greatest need and the most powerful weapon of the forester. The examples quoted shew that starting from a given mixture at an early age, the continued application of a settled policy can lead to extremely different crops, and they also shew that there are limits which we require to know, beyond which no amount of interference will succeed in forcing development to a desired end. Finally, the lesson is constantly cropping up, learn the silviculture of the individual species under the given conditions of climate and soil before you draw conclusions as to what will happen in a mixture.

GAME PRESERVATION IN THE CENTRAL PROVINCES AND BERAR.

BY TARA SINGH, I.F.S.

It is gratifying to note that opinion is now veering round and forest officers are thinking of the preservation of our forest fauna which has been treated to wholesale destruction for ages past! The readers of the *Indian Forester* may find the following account of some interest after reading " R. M. G.'s " admirable advocacy of " The need for game preserves," published in the August 1932 issue.

Shooting in the reserved forests of the Central Provinces and Berar is restricted by an annual revision of shooting blocks divided into—

I. absolutely closed and

II. conditionally closed.

The areas under the first category are closed to all public shooting (except in the case of carnivora under certain conditions). They form virtually small sanctuaries for a number of years—according to the discretion of the Divisional Forest Officer—and approved by the Conservator of the Circle.

Shooting permits of the public are issued by the Divisional Forest Officer for the " conditionally closed " blocks only. A check to protect the game in each of these shooting blocks is exercised by restricting the number of each species to be shot during the whole year. The permit defines the number and kind of animals to be shot by the holder, who sends in a statement of the game shot at the expiry of the period. This is checked with the report from the Range Officer who also keeps the Divisional Forest Officer informed of all illicit shooting. The game shot, whether by permit holders or illicitly, is recorded against the number and kind of animals permitted to be shot during the year. The list is consulted before issuing any fresh permits, thus affording an effective control over the question of game preservation.

The usual procedure followed is that the Divisional Forest Officer prepares a detailed list about August-September in each year, showing the total number of animals of each species to be shot in each of the shooting blocks of his division. He is vigilant in restricting to the minimum any particular species which may be deserving of special protection in the " conditionally closed " areas. This list together with his proposals regarding the " absolutely closed " areas is then submitted to the Conservator of Forests of his Circle for approval. Notifications prescribing the respective shooting blocks as virtual sanctuaries as well as those " conditionally closed " under certain rules are gazetted before the commencement of the shooting season for general information.

There are certain special areas in the province—like Banjar (Mandla), 199 square miles of Supkhar (Balaghat), 46 square miles of

Taroba (North Chanda) and perhaps others—which are now maintained more or less as *permanent game preserves* for the protection of the local forest fauna such as bison. No permits in these forests are issued except by the Chief Conservator of Forests himself. The Divisional Forest Officers act as game wardens for such areas and they submit quarterly reports to the Chief Conservator of Forests and the Local Government on the condition of game and illicit shooting.

Wild dog is definitely regarded as a pest and pig also receives special attention. Rewards are usually paid by Government for the destruction of the former, while free hunting of the latter is encouraged liberally, particularly in the neighbourhood of agricultural land where the pig has proved so very harmful to the field crops. Monthly reports regarding the destruction of the wild dog in the permanently preserved areas mentioned above are also submitted to the Local Government. The attention paid to man-eating panther or tiger is of course known to many, and anybody may secure a handsome reward from the Government when he has bagged a notified animal in any part of the Central Provinces and Berar.

It may perhaps be of interest to record here the details of the Reserved Forest areas which were notified under the various categories during 1931 in the Central Provinces and Berar Forest Circles :—

YEAR 1931.

Forest Circle.	*Absolutely closed. (Square miles).*	*Conditionally closed. (Square miles).*
Berar	58	5,311
Southern	249	6,421
Northern	469 (140 sanctuary for game, 329 closed for management purposes).	6,392
Totals	776 square miles.	18,124 square miles.
	18,900 square miles.	
Area preserved as more or less permanent sanctuaries (not notified)	245 square miles (of Supkhar and Taroba alone).	
Grand total	19,145 square miles,	

FOREST COLLEGE PRIZE-GIVING.

The prize-giving of both the Imperial Forest Service and the Forest Ranger Colleges was held in the Board Room of the Forest Research Institute, Dehra Dun, on the afternoon of 31st October 1932, and was attended by the officers of the Institute and the local forest officers. Mr. A. D. Blascheck, Inspector-General of Forests, presented the diplomas and prizes and in the course of his speech said :—For the sake of convenience we have combined the prize-giving of both colleges but at some future date I hope that both courses of training will be given in the Institute. At the moment we have to lament the temporary closing of the Indian Forest Service College and the abandonment of the Forest Rangers' course for 1932—34, but I see signs of more general appreciation of the importance of scientific forestry in India, and there is still great scope for its development.

In the *Indian Forester* for October 1932 there is a short account of the Indian Forest Service College with some observations regarding future needs. Judged by the number of forest officers trained the college has not been the success anticipated, but it rests with the few who have obtained diplomas to show that their qualifications are high.

I am very glad that the two students now leaving are well above the average of some previous classes. It is true that they have had the advantage of constant individual attention, but even in a larger class I believe that they would have stood high in the order of merit.

The prescribed course of training has been adhered to and on tours in the U. P., Bengal and Punjab distinguished forest officers have often accompanied them. Our thanks are due to these forest officers and to the Officer Commanding the Sappers and Miners at Roorkee and his staff for the trouble taken to make the course of training a success.

With so few students the only opportunity of playing team games has been with the Ranger College, but I hope that the youngest generation of forest officers will show no lack of energy for strenuous field work. Ramabhadran wins the Hill Memorial prize for silviculture and the *Indian Forester* prize for botany. The late Mr. H. C. Hill was Inspector-General of Forests and died in 1902, the prize being from

a fund provided by forest officers in his memory. Anvery wins the Hon. Member's prize for the best practical forester and the prize for zoology.

Ramabhadran qualifies for the Currie scholarship; its award rests with the Currie trustees. Mr. Currie was vice-president of the Council of India and in 1887 established a fund for prizes to be awarded to the Royal Indian Engineering College, Cooper's Hill. The Mason-Jaspal cup for tennis is not awarded. Before awarding diplomas and distributing the prizes I wish to say a few words about the Forest Ranger College.

The standard of the class now qualifying is well up *to average;* all the students have qualified for higher standard certificates and three have obtained honours certificates. These are most satisfactory results particularly as some of the students had difficulty in maintaining the required standard in the first year.

Tours have been made in a variety of forests in the United Provinces and our thanks are due to the forest officers who so kindly gave their assistance. Hockey, football, cricket and tennis matches have been played and the hockey team were only beaten after several hard games in the tournaments for which they entered. The sports were held in April and provided some well contested events. N. C. Mukerji had to yield the Championship cup he won in 1931 to Fazl Gul Khan of the junior class.

Niranjan Nath Koul, Rameshwar Nath Gupta and Dinabandhu Mukerji are awarded honours certificates, Niranjan Nath Koul receiving *the Gold Medal. Niranjan Nath Koul* is *also* awarded the silver medal for forestry and the MacDonell silver medal for the best Punjab or Kashmir student. Mr. MacDonell was himself a Punjab forest officer who spent many years in Kashmir. Dinabandhu Mukerji is awarded the silver medals for botany and engineering, and Rameshwar Nath Gupta is awarded the *Indian Forester* prize.

Kartar Singh is awarded the Fernandez gold medal for forest utilization and Hari Krishna Madhwal is awarded the William Prothero Thomas prize for the best practical forester. Mr. Fernandez joined the Indian Forest Service in 1873 from Nancy Forest School; he was

Director of the Forest School, Dehra Dun, and eventually retired as Conservator from Central Provinces. The medal bearing his name is obtained from interest from a fund subscribed by the C. P. forest officers in his memory. Mr. Prothero Thomas was also a C. P. officer and the prize bearing his name has been subscribed by officers in the Central Provinces.

In conclusion I wish to thank all members of the staff of the two colleges and the officers of the Forest Research Institute concerned for their work in making the courses a success. To you students I wish every success and happiness in the career you have chosen.

Prizes for I.F.S. Class of 1930-32.

1.	Currie Scholarship—all final examinations (£22/-) ..	C. A. Ramabhadran.
2.	Hill Memorial Prize for Silviculture (3 Volumes of Troup's Silviculture of Indian Trees) ..	C. A. Ramabhadran.
3.	Hon'ble Member's Prize for the best Practical Forester (wrist watch) ..	S. A. A. Anvery.
4.	*Indian Forester* Prize for Forest Botany (despatch box) ..	C. A. Ramabhadran.
5.	Zoology Prize (Binoculars) ..	S. A. A. Anvery.

Prizes for Ranger Class of 1930-32.

1.	Gold Medal for Honours ..	Niranjan Nath Koul, Kashmir State.
2.	Silver Medal for Forestry ..	Ditto.
3.	,, ,, Botany ..	Dinabandhu Mukerji, Assam
4.	,, ,, Engineering ..	Ditto.
5.	Fernandez Memorial Gold Medal for Forest Utilisation.	Kartar Singh, Kashmir State.
6.	MacDonell Silver Medal to the best Kashmir or Punjab Student ..	Niranjan Nath Koul, Kashmir State.
7.	William Prothero Thomas Prize for the best Practical Forester ..	Hari Krishna Madhwal, U. P.
8.	*Indian Forester* Prize (Consolation)	Rameshwar Nath Gupta, Nabha State.

Ranger Class Diplomas in Order of Merit.

1. Niranjan Nath Koul, Kashmir State.
2. Rameshwar Nath Gupta, Nabha State.
3. Dinabandhu Mukerji, Assam.
4. Kartar Singh, Kashmir State.
5. Narendra Chandra Biswas, Assam.
6. Hari Krishna Madhwal, U. P.
7. Pabitra Kumar Dhar, Assam.
8. Projendra Chandra Datta Purkayastha, Assam.
9. Janardan Parshad, U. P.
10. Phulel Singh, Kashmir State.
11. Allah Dad Khan, U. P.
12. Hamid Hussain Jafri, U. P.
13. Premomoy Purkayastha, Assam.
14. Shivanath Mital, U. P.
15. Dharam Chand, Chamba State.
16. Sri Kanth Nehru, Kashmir State.
17. Naresh Chandra Mukerji, Assam.
18. Mohamad Sultan, Kashmir State.
19. Kiran Chandra Das Gupta, Assam.

EXTRACTS.

REORGANIZATION OF KASHMIR GAME DEPARTMENT.

PROPOSALS for the reorganization of the Game and Fish Preservation Department and the Visitors' Bureau, Kashmir State, so as to attract more sportsmen and visitors are made in the report of the Kashmir Retrenchment Committee, the general provisions of which were summarized yesterday.

The Committee says :—

" The Game and Fish Preservation Department and Visitors' Bureau, which were amalgamated last year, are at present under the control of the Director, Kashmir Valley Food Control Department. We make no suggestions with regard to reductions. The Committee is of opinion that these two departments should be separated from each other and both transferred from the control of the Director, Food Control. The Game and Fisheries Preservation Department should, in our opinion, form a separate department and have its own separate Game Warden. It recommends further that it would be advisable to place the whole department under the control of the Chief Conservator of Forests. This arrangement would permit the work of the department being carried on with less difficulty than at present. It should lead to greater co-operation in those matters where the interests of the Game Preservation Department conflict with those of the Forest Department and *vice versa*.

"The normal work of the Game Preservation Department should be carried on by the Game Warden. Any conflict of interests should be adjusted by reference to the Chief Conservator of Forests who as head of both the departments should be responsible for the protection of the interests of each. It is thought by this Committee that there are several advantages to be gained by such an arrangement.

(*a*) Removal of difficulties as a result of conflicting interest by the best possible adjustment of them by the Chief Conservator of Forests.

(*b*) The interests of Game Preservation would be considered by the Forest Department officers to a greater extent possibly than is to be expected under the present arrangement.

(*c*) Removal of dual control in the matter of illicit grazing, grass cutting, timber cutting, etc., in reserved game areas and sanctuaries.

TROUT WATERS.

(*d*) The better control of floating operations on trout waters in the fishing season so that fishing is interfered with as little as possible, thus removing causes of complaint and leading to the attraction of more sportsmen to Kashmir.

(*e*) The provision of bridges over trout waters by co-operation between the Game Preservation Department and the Forest Department.

"The Chief Conservator of Forests when he is the official head of the Game Preservation Department should be able to obtain for the Game Warden the co-operation and assistance of the whole Forest Department staff in the moffussil. This fact in turn should permit reduction to be made in the number of Game Preservation Department watchers and forest guards, in such areas where special watchers or special guards are not necessary, and thus lead to retrenchment without loss of efficiency.

"It is necessary that the Game Warden should have adequate knowledge of the habits of big game, small game and trout culture in addition to an ability to discuss these subjects with sportsmen visiting Kashmir, and of controlling the ordinary correspondence and working of an office. Proper inspection must involve absences from headquarters for periods of at least three weeks or a month at a time. For this reason the Game Warden requires the help of a capable Assistant Game Warden so that when one is on tour the other is at headquarters to dispose of office routine and correspondence to interview visiting sportsmen and to give them help and advice.

(*Statesman*—23rd October 1932.)

WOOD FOR THE WINE TRADE.

Reports of Government committees are so generally regarded as dry reading that it deserves to be recorded that the Imperial Economic Committee start off their latest report with an original touch that at once captures the imagination. It is the subject, of course, that inspires this departure from usual practice, for the report is on "Wine"—the preparing for market and marketing of wine.

"Throughout the ages" (state the Committee) "literature abounds in references to wine. No food, no other drink has similarly inspired the poet or stimulated the reformer. It 'maketh glad the heart of man'; on the other hand it is described as 'a mocker.' Whichever view may be favoured we, in this report, deal with wine as a commodity which Governments delight to tax."

The main body of the report is, of course, concerned with wine, and in particular with the prospects of increasing the Empire share in the U. K. market; but since wood is so essential for wine storing and transport, a section of the report is devoted to wood supplies. It appears that considerable difficulty is met in the wine trade in Australia owing to the shortage of locally-grown wood suitable for making barrels and casks. Oak for these purposes is imported from the United States and manufactured into casks in Australia. Such casks cost from 54s. to 65s. each according to conditions in the coopering trade. A hogshead is approximately 65 gallons, so that the cost of the wood may be from 10d. to 1s. a gallon, which has to be charged to the purchaser in the United Kingdom. Some casks are shipped back again to Australia for further use, but the freight, although recently reduced from 75s. to 45s. a cubic ton, is expensive.

Woods that may impart Flavour.

Returning the casks in shook is not at present practicable as, owing to the changes in temperature on the journey, the wood develops a mould. The return of whole casks costs about £1 for a hogshead, and is a saving of cost, but there have been difficulties with the coopers' unions in Australia who do not encourage the return of whole casks. Casks in which whisky has been imported to Australia are greatly in demand for transport of wine but the supply is insufficient. Oak is the most suitable wood for holding wine. Supplies of oak are, however, not available in sufficient quantity in the British Empire for the purpose.

It is usually considered that many of the hardwoods of Australia and New Zealand are not suitable for casks, as they impart a flavour to the wine However, in describing the woods suitable for port wine in Portugal, Mr. Geoffrey M. Tait (in his *Practical Handbook on Port Wine*) places first the Baltic oak, known as Memel or Stettin, then Adriatic oak, known as Trieste and Fiume, and adds: "Next in quality comes New Orleans oak, but Eucalyptus, although less known and more difficult to procure, is probably not inferior provided it is carefully chosen and very well seasoned. It is quite erroneous to imagine that this wood has any taste or smell of Eucalyptus oil, and it has been proved that it gives less taste to wine than New Orleans oak."

It will be observed (states the report) that this authority lays great stress on the need for the wood to be very well seasoned. He states that a new cask is seasoned with steam and ammonia, after which it is washed with water and seasoned with a young wine. The longer the process of seasoning with wine the better, as even after some years the wood imparts its particular flavour to the contents of the cask. It seems desirable that further investigation should be made into the suitability, after due seasoning, of Australian hardwoods, for use in maturing Australian wine.

NOTES ON EMPIRE WOODS.

The Department of Scientific and Industrial Research, London, have furnished a note on the available information on the subject of Empire timbers which may be suitable for making wine casks (printed as an appendix to the report), and the Department report that Tasmanian oak, blackwood and mountain ash are said to be suitable for beer casks, but that they have no information as to their uses for wine.

The difficulty in South Africa is possibly still greater. Casks have to be imported empty or in shooks, as local supplies of suitable wood are not available.

The note by the Department of Scientific and Industrial Research, London, states that a search through their records yielded comparatively little information concerning Empire timbers of proved suitability for wine casks, while inquiries have been made in other directions as well. The information is briefly summarised as follows :—

INDIA.—From the summary of uses and availability in the book on *Indian Timbers* under preparation by R. S. Pearson and H. P. Brown : 1, *Grewia tiliaefolia* is described as having been passed as eminently suitable for liquor kegs by a firm of English manufacturers. Largest and best logs procurable from Coorg; estimated that 1,500 tons will be annually available.

2. *Grewia elastica.*—Troup states is suitable for beer casks. Parker says that small supplies could be obtained from the Punjab : in the United Provinces it is more common. Kanjilal states it is very common in both the *sal* and mixed forests of the Siwaliks and Ganges divisions and in the outer forests of Jaunsar.

3. *Quercus dilatata.*—Cooper estimates that 5,000 cub. ft. could be procured annually from the Naini Tal Division of the United Provinces. It has been thoroughly tested for casks and barrel making by the Government Wood Working Institute at Bareilly, and found to be very suitable for the purpose.

4. *Artocarpus hirsuta.*—Fairly common on all West Coast Divisions, but at present only exploited from the more accessible forests. Considerable quantities untouched in the more inaccessible evergreen forests: 16,000 cub. ft. annually available from the Urti Block of the Markut forests. Generally speaking, the present supply of this valuable timber is insufficient to meet the local demand.

FEDERATED MALAY STATES.—No timbers of suitable quality appear to be available. It is said there are plenty of woods strong enough, but usually they are highly coloured or contain soluble resins and oils.

BRITISH NORTH BORNEO.—There is no information meantime as to any timber being suitable.

NEW ZEALAND.—The woods mentioned here are: Southland beech and tawa. It might be well to suggest kauri pine.

AUSTRALIA.—In Australia itself, although in Mr. E. H. F. Swain's book " The Timbers and Forest Products of Queensland," the timber known as yellow-wood ash is mentioned as being used in competition with imported oaks for the making of spirituous liquor casks, and stated to impart a faint taste, it seems fairly reasonable to assume that the Australian timber trade would of itself have examined and submitted

local woods for use had they been proved entirely satisfactory. Tasmanian oak, blackwood and mountain ash are said to be suitable for beer casks, but we have no information about their use for wine. Should the New Zealand kauri pine be considered, then also might be the Queensland kauri and possibly hoop pine. Generally speaking, however, the softwoods do not seem to be favoured for wine casks.

AFRICA, BRITISH HONDURAS, BRITISH GUIANA AND THE WEST INDIES.—As yet one can learn of no suitable timbers from any of these British Oversea possessions.

CANADA AND GREAT BRITAIN.—British oak is suitable, and so is the white oak in Canada, but in neither case does the supply meet the demand for other uses.

" In general, we are told that oak is looked upon as the key wood in the wine trade, since it imparts a character or mellowness which no other wood as yet seems to do," concludes the reference to wood for wine.

(*Timber Trades Journal*, 1st October 1932.)

DAMAGE TO TEAK LOGS IN SHIP HOLDS.

An inquiry which recently came to the timber section of the Botanical Department of the Free Public Museums, Liverpool, led Mr. H. Stansfield, A. R. S. C. (Lond.), D. I. C., Keeper of the Department of Botany, to investigate the deterioration in certain logs of teak (*Tectona grandis*) from Burma, due to the bamboo shot-hole borer (*Dinoderus minutus*—family, *Bostrychidæ*).

The results may be of interest as this beetle has not previously been cited as doing damage by boring into teak. Most of the *Bostrychidæ* are tropical or sub-tropical insects. They are rarely found in timber in this country. The bamboo shot-hole borer is common throughout India, and is occasionally found in bamboo-work and basket-work in houses in this country.

The logs of teak were 7 ft. long, with an end section of 3 in. × 6 in. They contained from 30 to 40 " worm-holes," due to the borings of the beetles. Each " worm-hole " extended to a depth of from ½in. to ¾in. An examination of the tunnels showed that they were first bored by the adult beetles at right-angles to the axis of the tree for a distance of ½in. The direction of the tunnels then changed to a position at right-angles to the straight shaft from the surface and parallel to the axis of the tree for a distance of about ½in.

At the time the examination of the wood took place most of the " worm-holes " were empty, some contained living beetles, others portions of cast skins and others newly-hatched beetles.

Some time afterwards it was ascertained that during transit from Burma the teak had been placed in the hold of the ship in close proximity to bamboo canes, which were used for dunnage. A number of these canes were examined and found to be heavily infested with active beetles and full-grown larvæ. It is Mr. Stansfield's opinion that, due to the movement and crushing of the bamboo in the hold of the ship, large numbers of beetles were shaken out and passed on to the teak, where they commenced boring. It is possible that active larvæ were also shaken out, and a few of these would enter the borings made by the active beetles, which would account for the

pupæ and recently-emerged beetles being found in the tunnels in the teak. The last stages in the life history of some of the beetles were completed in the teak in the period of transit from Burma.

This beetle is liable to be carried about the world with bamboos, and although it is unlikely that it could ever thrive in timber stacked in this country, it might be a source of considerable loss to timber merchants with depots in tropical countries, where teak is stacked in close proximity to bamboo or other woods which harbour the *Dinoderus* beetle, and the same danger would be ever present where infected bamboo was used as dunnage in the holds of ships carrying cargoes of timber.

In the logs in question ¾in. all round will have to be cut away to regain a solid surface and to remove completely the beetle-infested zone of wood.

(*Timber Trades Journal*—10th October 1932.)

[On enquiry from the Forest Entomologist we learn that the likelihood of damage from this cause occurring in teak depots in Burma and India is very small. The case is of considerable interest in showing how easily prejudices against imported timbers may arise from rumours circulated amongst timber merchants and the need for early publication of definite results in research work.—ED.]

AFFORESTATION WORK IN THE CENTRAL PLATEAU OF FRANCE, WITH SOME NOTES ON THE WORK UNDERTAKEN AT THE MILITARY CAMP OF LA COURTINE.

BY PROFESSOR E. P. STEBBING, F.L.S., F.R.S.E.,
Professor of Forestry, University of Edinburgh.

(*Extracts from a lecture delivered to the Royal Society of Arts on* 9th March 1932.)

The region to be dealt with is not well known to the British tourist in France. In addition to the two spas of La Bourboule and Mont Dore it possesses some grand scenery and magnificent roads. Beautiful forest-filled glens, each with its rocky sparkling trout-filled stream, are flanked by wide stretches of heather-covered country, dotted here and there with small woods and villages, backed by the slopes and crests of higher hills. Auvergne has been likened to a pocket handkerchief edition of the Alps and Pyrenees, a not inapt comparison. It also includes some small towns of great antiquity and interest.

The area of France under forest amounts to 19 per cent. of the total area of the country. Apart from the forests it is estimated that there are some 10,600,000 acres of uncultivated lands (including tracts of glaciers, rocks, screes, etc.) in the ownership of communes and private proprietors, of which in some departments at least 50 per cent. could be afforested, without entrenching upon possible future extension of arable lands or grazing areas. The departments of France specifically referred to in this paper are le Puy-de-Dome, le Cantal, la Haute Loire, la Creuse and la Correze, which form the S. E. section of Auvergne. In these departments there are extensive tracts of heather and broom-covered rolling hills and plateaux of poor soil termed " landes " whose full productive power can only be attained through afforestation. The climate of this mountain area is a rude one ; the winter is long, during which the inhabitants

of the unforested tracts can find no employment, either for themselves or their animals. If they emigrate to the towns they do not come back, and agriculture loses thereby. It is pointed out that the countryside in some regions (and the same is true in parts of Great Britain) is becoming depopulated; that large schemes of afforestation on the communal lands will keep the people in the villages; and that the employment in the forest work, to be followed as soon as the plantations commence to yield produce, by the installation of sawmills, etc., combined with exploitation operations, will afford a variety of work to certain sections of the population during the winter, and to others throughout the year—arguments perhaps more readily understood in France, by reference to existing wooded tracts and their associated industries, than in Britain, and therefore carrying more weight.

STATE AID FOR AFFORESTATION.

Only exceptionally are grants in money made to private proprietors, in cases where the afforestation work to be carried out is in the general interests of the community (as, for example the plantation of areas subject to bad erosion endangering valuable land below, or in order to regularise the flow of water in streams, etc.); or where, owing to lack of labour, as in the departments of la Correze and la Creuse, the afforestation work has to be made over to commercial firms expert in this type of business, who furnish both the plants and the labour. For instance on the plateau of Millevaches (la Creuse) grants of money up to 50 per cent. of the total outlay have been made.

A far-sighted rule, of especial benefit to the communes and syndicates or sections (groups of villages), allows manual labour to count towards the expense of the undertaking. Thus so many days' manual work or the participation of the village transport in the operations calculated at its monetary value, is allocated against the total cost of the operations. If the preparation of the area and the sowings or plantings are undertaken between November and April, that is in the dead season for agricultural work, it becomes obvious that the owners of communal land can, without any disbursements of cash, acquire an important forest capital, the only charge upon them being so many days' free labour during the course of the season's operations, which must represent one-fourth of the total cost.

State Acquisition of Land by Purchase.—The State through the Forest Department is taking a share in this new afforestation work. Sums are set aside in the State Budget for the purpose of acquiring by purchase ruined forest areas with the object of restoring them to more normal conditions; also for the purchase of poor barren lands, such as are abundant in the Central Plateau, in situations where the afforestation will be to the public benefit.

Methods of Propaganda to Assist Afforestation.—It must be understood that under the existing laws the State has no power to force either the communes or the private proprietors to afforest their poor bare lands; the exceptions where the contrary is the case, areas subject to severe erosion, etc., are well known. Consequently in the case of the communes it is only by propaganda and the exercise of great tact that the forest officers can overcome the prejudice of the villager to undertaking

a work of which he himself will not reap the profit. It should be added that once the commune has accepted monetary assistance from the Government to afforest a portion of its lands, the woods thus formed are looked after to a certain extent by the officers of the forest department, though the forest guards in charge of the areas are paid by the commune and take their orders from the mayor. All areas so afforested are placed under working plans and all thinnings are marked by the State forest officer.

The importance of this new work has been fully recognised by the Government and has led to considerable increases in staff in the Puy-de-Dome. In 1921 a special cadre termed Ameliorations Pastorales was formed. A senior officer was appointed to this post with a smal lstaff. His duty was to visit the upper regions of the mountains in the department of the Puy-de-Dome, Cantal and Haute Loire, to study the possibilities of afforesting the poorer areas and of improving the grazing of the better pasture lands; and then to persuade the owners, communes or private proprietors to apply for State help to enable them thus to enrich their properties. This departure proved so successful that in 1931 this additional staff was increased; as also that of the Puy-de-Dome. And a new conservatorship was formed at Clermont-Ferrand, M. Courtain, the first officer in charge of "Ameliorations Pastorales," being appointed to the post.

Forestry propaganda in the region is not restricted to the State forest staff. There are a number of private forestry societies, all of whom possess nurseries of varying size, whose maintenance is assisted by grants from the Produit des Jeux and from which the members obtain annual allocations of plants. It is impossible to deal with these societies here, interesting as their activities are. One of the largest will be instanced, the Auvergne and Plateau Central Branch of the Societé des Amis des Arbres. This branch comprises a thousand members amongst whom are several conseillers généraux, retired and serving State forest officers, many private proprietors, men in the professions, and others. The branch carries on an active and informative propaganda in the cause of afforestation. Aided by the subscriptions of its members, allocations from the Produit des Jeux and the local administration of the department concerned and assisted by the forest department, who furnish the branch, so far as possible, with seedlings to line out, it maintains small nurseries scattered through the mountains, which enable its planting members to obtain plants of the best species for the particular locality.

Grants from the Produit des Jeux.—After the deduction of 4 million francs, made in favour of certain organizations and public establishments, from the total sum received from the games (casinos, etc.) and the allocation of two-thirds of the remainder to assist the introduction of public works in connection with modern sanitation and hygiene the remaining third is to be used as a fund to serve the following : (1) to increase the grants provided for under the Finance Acts, of 31st March, 1903, and 13th July, 1911, to assist works for the provision of drinking water, (2) to assist public works of interest and value, such as afforestation, improvement of pastures, fisheries and shooting lands. Two-fifths of this third will be allocated to projects and works for the provision of reservoir and drinking water; whilst other two-fifths will be divided between the State, the

départements, the communes or forestry or pastoral associations with the object of aiding the development or constitution of forests, or pastures, either State, departmental, or communal; and the remaining one-fifth will be allocated to communes or associations who undertake to preserve or rear game and fish. The allocation of grants under the last three-fifths mentioned above will be made by the forest department. It will be apparent that so far as forestry is concerned there were two sources open from which grants could be obtained (*a*) from the State Budget direct, (*b*) from the Produit des Jeux. The total sum allocated from the Produit des Jeux for afforestation during the financial year 1930-31 amounted to some 8¾ million francs.

The Afforestation work in the Region.—The area comprised in the Auvergne region of the Plateau Central is wild and mountainous and exposed to rude climatic conditions. Standing up out of the great central plains of France it is swept by strong winds of gale force, is subject to severe forests and at times to late falls of snow as for example the exceptional fall in May, 1926. In the summer the temperature is high and seedlings require protection from scorching by the sun's rays both in nurseries and in new plantations. This rough territory embraces large areas of poor heath lands interspersed, as is common in this type of country, with rocky outcrops and screes and bogs in the depressions. Over large areas the heather is of the dwarf type permitting broadcast sowing; in others, stretches of heather of a higher and stronger growth are interspersed with expanses of tall broom and so forth. At many points the aspect of the countryside resembles parts of Scotland or the heather-clad hills in England.

Apart from the old-type pure silver fir or mixtures of silver fir and beech of this region owned by the Government and private proprietors there exist certain areas of Scots pine or of spruce or pine and spruce mixed in the region which owe their *origin to an afforestation campaign which was inaugurated about 1850 and was pur*sued until 1870. This was commenced by a few private proprietors assisted by the Government forest officers. It was an endeavour to show the private proprietor and the communes the advantages of afforestation. It met with great opposition from the latter and died away after 1870. To it the region owes some magnificent areas of 60-70 year old pine forest and at higher elevations spruce, or the two in mixture. The pine is remarkable for its height, cleanness and symmetry of the boles and the volume per acre on the ground. The present treatment of these woods will be alluded to later.

Methods of Undertaking the Work.—In the case of afforestation work undertaken by private proprietors who solicit State assistance seed or plants are furnished gratis by the Forest Service department. The plants come either from the State nurseries or are bought from commercial nurserymen. The sowing or planting is carried out by the proprietor. The Forest Service give technical advice when asked for and restrict further inspection to satisfying themselves that the seed or plants have been correctly put in and that the resulting young crop is successful. In the case of the communes the grant is also free but the work is undertaken under the direct supervision of the Forest Service. The following remarks apply chiefly to the communes.

(*a*) *Sowing.*—Sowings are either broadcast or in patches; owing to the cheapness of seed the latter is seldom used. Broadcast sowing is almost exclusively confined

to *Pinus sylvestris*, chiefly the Auvergne variety. Five kilograms (of 2¼ lbs.) of seed are broadcasted to the hectare (2½ ac.). This method is only carried out on areas of low-growing heather when moss is absent ; or land which has had a crop of cereals sown sparsely, after ploughing with a tractor, and reaped high. Areas of low heather which have only a light moss cover are scratched with a harrow before being sown.

Lastly, areas of high heather, where the latter has been partially torn up by a heavy harrow and then burnt off in summer ; the area then lies fallow for a year by which time a young new growth will have appeared, over which the seed is sown in the (second) Spring. It is essential that the young seedlings should be protected by the existing cover on the ground against sun scorching in the summer and frost lifting during the winter months. The seed is broadcasted in early Spring, sometimes whilst snow is still on the ground, the latter ensuring the seed gradually reaching the soil with the melting of the snow.

(*b*) *Planting.*—Wherever sowing cannot be carried out with a strong possibility of success, planting should be resorted to. The method most commonly in force is to plant each plant in a cleaned patch, 2-year seedlings being used or 2-1 year at high elevations ; the distance between the plants (*i.e.*, spacing), depends upon whether (1) the existing cover on the ground is more or less aggressive, (2) the species is a shade bearer or light demander, and (3) frost lifting is a serious danger or otherwise. 5,000 plants to the hectare is considered to be the minimum, the spacing of the plants being about 1 metre 30. If the distance between the plants is greater the branches persist, and " apple trees (pommiers) " are obtained, which do not shoot up with elongate clean stems. It may be pointed out that the region experiences three months of great heat during the summer with a very dry atmosphere. These conditions cause the lower branches to dry and drop off whilst quite small at a planting distance which would not yield the same results in Britain owing to the far damper atmosphere.

Planting in the patches above described is the commonest method in force. But more recently excellent results have been obtained in the West Clermont district by making use of the hollow dibble (plantoir prouvé). Using the hollow dibble the plant can be placed in position without disturbance of soil or surface vegetation, and enables the plant to be placed in a tuft of heather or grass, which protects it.

Species used.—The species in most common use for new afforestation work up to 3,000 ft. is the *Pinus sylvestris*, Auvergne or du Velay varieties. This species is eminently suitable to all the bare heath-covered, etc., lands and gives good results, as already proved by the returns from the woods formed between 1850 and 1870 now under exploitation. It also facilitates the introduction of silver fir beneath its comparatively light canopy at a later stage. In the Cantal *Pinus laricio* is often used with good results. Next comes the European or Norway spruce used on wet soils at high elevations (usually above 3,000 ft.). In the Cantal it is planted in groups in the proportion of quarter to half with pine. From the results of the 1860 plantations this species has produced some fine woods in the Puy-de-Dome, in the State forest of Murat and in the communal forests of Albepierre and Laveissiére (all in Cantal). The species is often attacked by heart rot at the base of the stem towards 50 years of age, especially when grown pure.

The silver fir (*A. pectinata*) is magnificent and grows very fast in the region. It provides the markets with the most sought-after timber. It is therefore regarded

as the species of the future and all the 1850 --1870 Scots pine forests are now being under-planted with it under the new working plans. As it is a shade-bearer and, subject to both frost and sun scorching, it can only be introduced either under an existing soil cover or under tree crops (except spruce) standing on the area. In the Scots pine woods it is being planted in uneven-aged groups after the removal of the pine, the groups gradually coalescing to form an uneven-aged forest to be managed on the selection system. Beech is a native of the country. It is valuable in mixture or as an undergrowth or second storey in silver fir, etc., crops. As in the case of silver fir it can only be introduced under a shelter cover.

Experiments are being carried out with the introduction of exotics such as the Douglas fir, Sitka spruce, Japanese larch and cedar, the latter on the warmer aspects. Some promising young crops are to be seen but the species can scarcely be said to have been tried out and, as in Great Britain, mistakes have been made by planting them in uncongenial situations. In how far these species can become serious rivals to the all-popular silver fir, or produce as good results as the Scots pine on bare land, remains for the future to disclose.

Forest nurseries.—The first essential towards encouraging afforestation in the region is held to be that all plants given free by the State should be transplants, with good bushy root systems and of good healthy growth ; and that there should be a certainty that they will be well planted out. It is also prescribed that the larger proportion of the plants so given should be provided from the nurseries of the region. This decision is based on the accepted factors that the plants are acclimatised to the conditions they will have to face, and the transport of plants, reduced to a minimum, enables them to be planted out with the shortest delay after being lifted in the nursery. This has also proved to be one of the strongest assets in propaganda. A proprietor visiting a well kept nursery, with a fine lot of plants *en évidence*, is at once tempted to ask for a supply, should he have an area which might be planted. During the 10 years I have known Auvergne I have often seen instances of this, both in the case of private proprietors and of representatives of communes.

The statements [not reproduced] display the remarkable increase in the afforestation work, especially notable in the years 1928—1930. For example :—

Puy-de-Dôme—In 1924, 124 kilog.	of seed	sown	and	1,530,750	plants	planted.
In 1930, 1786	,,	,,	,,	2,813,750	,,	,,
Cantal—In 1924, 914	,,	,,	,,	640,200	,,	,,
In 1930, 977	,,	,,	,,	947,950	,,	,,

As regards the number of communes who have joined in the important work, the Cantal has a sparse population, and has not been able to play a big part. Nevertheless, in this department, and the Haute-Loire, some 8-10 communes have now applied for grants for afforestation purposes. In the Puy-de-Dôme since 1922, 47 communes have already afforested areas of their lands or are engaged upon the work, some of which, especially the sowings, are showing remarkable results. For example, Commune Bromont-Lamothe. Broadcast sowing of Scots pine over an area which had been ploughed with a Ford tractor and had one crop taken off it, reaped high. The same species broadcasted on short heather land in the communes of St. Sulpice and de Messeix ; sowings in patches on heather land in the commune of Mazayes. Scots pine and spruce plantations at Totebesse, St. Sulpice and St. Julien-Puy-Laveze ;

finally the spruce plantation at Nébouzat planted with the hollow dibble in high mountain pasture land, elevation between 2,550 and 3,450 feet with a 90 per cent. success.

That this work has made an impression in conservative quarters is shown by the fact that the Forest Department last year were asked by the Department of the Puy-de-Dôme to afforest 100 acres of the upper slopes of the Puy-de-Dôme itself, whilst the Military Department wishes to have 75 acres of the Manœuvre Camp at Bourg-Lastic planted.

Afforestation work at the Military Camp of La Courtine.—Since it has some bearing upon the general post-war afforestation policy, I propose to add a few brief remarks upon a far larger piece of military afforestation work which had been undertaken by the Forest Department, at the instance of the War Department, in connection with the large manœuvre area known as La Courtine in La Creuse. This camp was formed in 1904 and comprises some 15,000 acres in extent. The area presents all the features of the region—an expanse of rolling heather-clad hills with easy slopes for the most part, interspersed with patches of woodland, some of several hundred acres in extent, with bogs in the hollows. Along the northern boundary there is an interrupted belt of forest. A few of the woods on the area are the result of the 1850—70 afforestation campaign in the region, dating from 1870, whilst one or two of the younger were formed in 1912 by broadcasting Scots pine seed. The one near the Puy-de-Jaule has an average height of 18—20 feet (1930). The growth is excellent and the branches already dead for two-thirds up the stem. The total area of forest within the camp is 2,200 acres.

As will be evident from the Puy-de-Jaule young wood the question of afforesting other areas had been under consideration before the War. The necessity of some considerable planting became even more evident after the peace and the matter was actively taken up. The main procedure ultimately settled upon was on the lines of the work proceeding in other parts of Auvergne. But tactical questions—manœuvring, gun fire, field and underground telephones and so forth had naturally to receive the first consideration in the selection of areas for afforesting.

Before the War, apart from isolated areas and ruined woods, the existing forest belt consisted of 724 acres, broad-leaved; 405 acres, conifers; 631 acres, coppice with standards; 75 acres, coppice; or 1,835 acres. These had been placed under the management of the Forest Department and were yielding an annual revenue of half a million francs by 1925. The afforestation question was re-opened in this latter year and a carefully considered plan drawn up. It had been pointed out that in many parts the camp was becoming naturally re-afforested with birch and Scots pine, especially in the north and central parts, the latter having blocks of conifers pre-existing on the expropriated village lands taken up to form the camp. The northern zone was chiefly under consideration. It was decided to join up the interrupted blocks of forest by afforesting the gaps so as to form a belt of a depth of 500 metres. This belt would be outside the range of artillery fire owing to the proximity, on the outer boundary, of inhabited houses and agricultural lands. Included in this perimeter zone were considerable expanses of heather-covered land affording a very inferior pasture. The first step was to choose a site for a nursery, and I had the privilege of accompanying the party of military and forest officers on this quest in 1925. A considerable part

of the camp was traversed and a site of 5-6 acres chosen at Magnat-l'Etrange, close to the forest guard's house at Nouaillat. But little planting work was done in 1926 as credits and labour had to be arranged, all the money coming from the Produit des Jeux. The camp was divided into four sections, three under the Forest Department for forestry purposes. The annual planting area was thus distributed over the three sections, so as to ease the labour problem. The nursery proved a success from the start, and with the agreement of the Military Authorities, it was laid down that all surplus plants should be given free to neighbouring communes or private proprietors on the Millevaches Plateau who wished to afforest their lands.

The summary of the afforestation work undertaken between 1925 --1929 inclusive, is as follows :—(1) Sowing of 1,360 kilogrammes of seed of Scots pine on heather lands only ; (2) sowing of 160 kilogrammes of silver fir (*A. pectinata*) in blanks and glades in areas of poorly stocked broad leaved woods to improve the stocking ; (3) planting of 460,000 Scots pine, spruce, silver fir and *P. laricio*, all supplied from the nursery at Magnat l'Etrange. The area newly afforested amounted to 792 acres. It was pointed out that when the operations connected with the northern belt of forest had been completed the State would have a solid block of forest of 2,800 acres in extent (omitting the other areas of forest within the camp). This would greatly enhance the area of State forests existing in the district outside the camp which only amounted to 3,400 acres, excluding communal and private forests.

OBITUARY NOTICES.

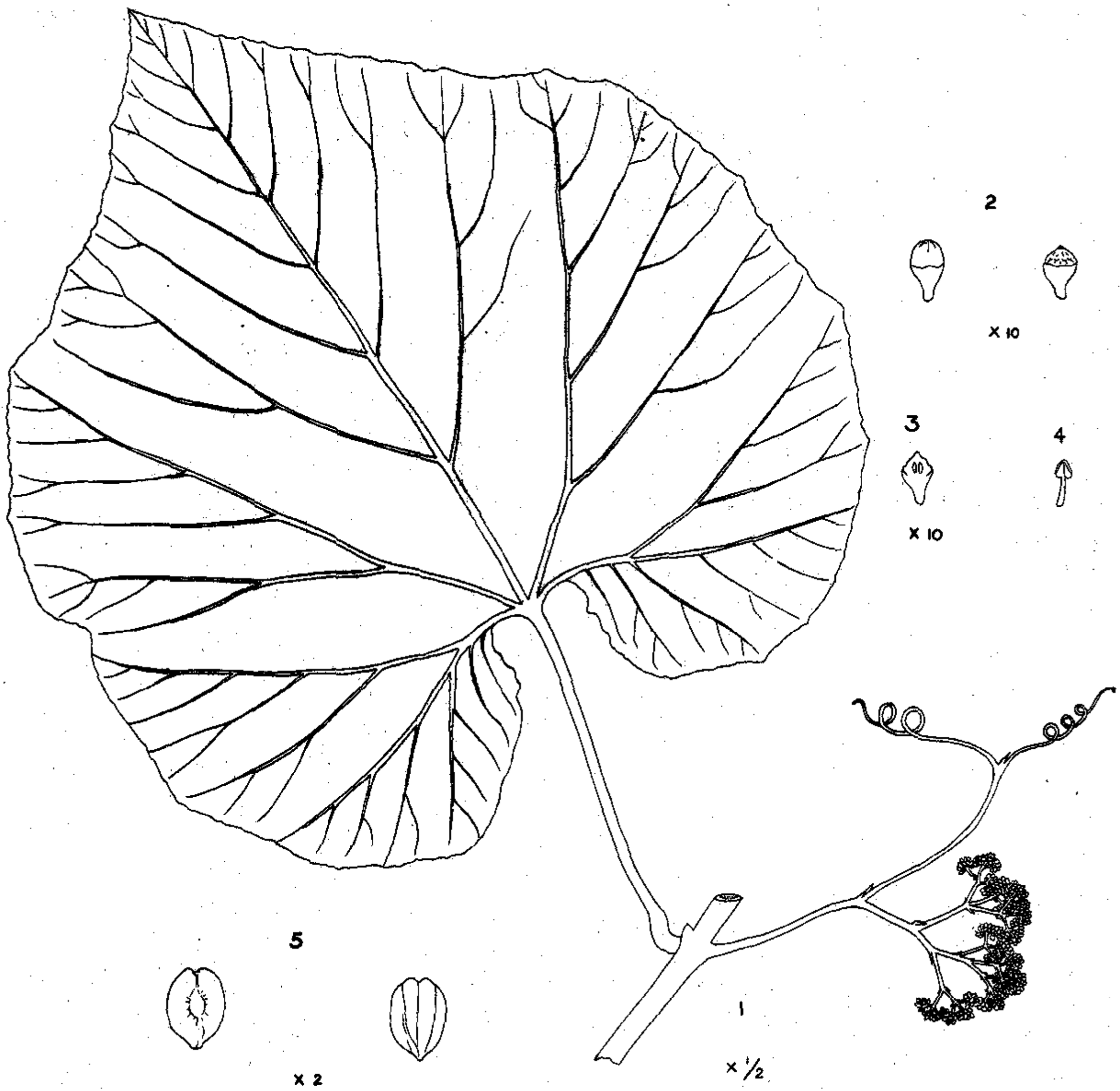
J. C. McDONELL.

Joseph Corne McDonell, a father of the Indian Forest Service, who died on November 15 at the residence of his son-in-law, Major E. C. Barnes, at the age of 83, will be deeply regretted.

Born in Australia on March 14, 1849, he came to England to be educated at Dulwich College, and when still in his 'teens took passage in a sailing-ship round the Cape to Calcutta. He landed in an India which was still recovering from the effects of the Mutiny, and his first appointment was to the Police, but he soon saw possibilities of more rapid promotion in the newly opened Forest Service. There he made his mark, eventually being the first Conservator of the vast and, till then, unconserved Kashmir Forests. He held that post for 13 years, and was so enamoured of life in the Vale of Kashmir that on his retirement he decided to spend his summers there and the winters in the Punjab. In the latter part of his life he was well-known to all who visited or spent their leave in Kashmir, his grey goatee beard and speed on the hill sides earning him the nickname of " The Markhor."

A. P. GRENFELL.

On passing out first from Coopers Hill in 1889 Grenfell was posted to the School Circle of the N. W. P. & Oudh as Assistant Conservator of Forests, and was attached to the Jaunsar Forest Division under E. McA. Moir. After learning under the able guidance of Moir he was placed in charge of the Saharanpur Division, and subsequently to that of the Dehra Dun Division, but he retired from the Forest Service on medical grounds in the year 1903. Grenfell was also lecturer in Mathematics at the Forest College in addition to his territorial charge of the Dehra Dun Forest Division, and his valuable " Manual of Mathematics " was used for many years by the students of the Forest College, Dehra Dun. He died on 24th November at Wells, aged 64.



VITIS RUGOSA, WALL.

Ganga Singh, del.

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VITIS RUGOSA WALL. AND *VITIS* SPP.

BY R. N. PARKER, I.F.S.

I have long contemplated preparing an account of the Indian species of *Vitis sensu stricto* and of *Vitis rugosa* Wall, which although an *Ampelocissus* has been frequently confused with species of *Vitis*. I have not done so hitherto mainly owing to being unable to obtain any specimens of *Vitis lanata* Roxb, from the Circar mountains, *i.e.* Roxburgh's type locality. The only specimens I have seen other than Himalayan ones are two which Mr. Gamble kindly lent me from his own herbarium ; one came from Vizagapatam and the other from the Godavari district. Both are sterile specimens but as far as comparison is possible they agree with some Himalayan ones and with a photograph of the type of *Vitis heyneana* Roem. and Schult. The type of *V. heyneana* R. & S. is preserved in the Naturhistorisches Museum, Oldenburg, and I am indebted to Prof. Dr. Diels of Berlin for kindly procuring me a photograph of it. It is I believe the same as *V. lanata* Roxb. of which Roxburgh left an unpublished coloured drawing. *Vitis heyneana* R. & S. was described in 1819 whereas *V. lanata* Roxb. was not described till 1824. Whether these specimens from the Eastern Ghats are identical with Himalayan ones can only be definitely settled when better specimens are available and particularly specimens showing ripe fruits.

Vitis pedicellata Laws. presents a further difficulty. The type specimens in Kew are poor and though we have some from Kumaon which agree with them I have a suspicion that *Vitis pedicellata* Laws. is a hybrid *V. jacquemontii* $\times$ *V. parvifolia* Roxb.

The following specimens in my opinion are *Vitis pedicellata* Laws.:—Garhwal, Osmaston 415, 462, 673. Naini Tal, Hira Singh 219.

Finally in the East Himalaya, the Khasia hills and Manipur is another species near to but not identical with *V. parvifolia* Roxb. Planchon in *D. C. Mon. Phan.* V p. 349 suggests that it is typical *V. flexuosa* Thunb. The specimens are very uniform but unfortunately none of them show fruit. This species is represented by the following sheets :—

Sikkim King : Butan King's collector 429 : Khasia hills Gallatly 180, Kurz 118, 538, Hooker and Thomson, Clarke 38378 ; Manipur Watt 6752, 6762.

The following is therefore only a tentative key to the species of *Vitis sensu stricto* found in India :—

Seeds with the chalaza depressed or indistinctly raised at the bottom of a depression, not continuous with the raphe.

Leaves with lax tomentum beneath : 1. *V. heyneana.*

Seeds with a raised chalaza continuous with the raphe.

Leaves with dense felted tomentum beneath : 2. *V. jacquemontii.*

Leaves nearly glabrous : 3. *V. parvifolia.*

1. *Vitis heyneana* Roem. & Schult. Syst. Veg. V (1819) p. 318. non Wall. *ex*-Wight and Arnott. *V. cordifolia* Roth non Muich. *V. lanata* Roxb.

Kumaon Almora Duthie 2887, Parker 2039, 2039A.

Sikkim King 4825, Thomson, Gamble 452, 575.

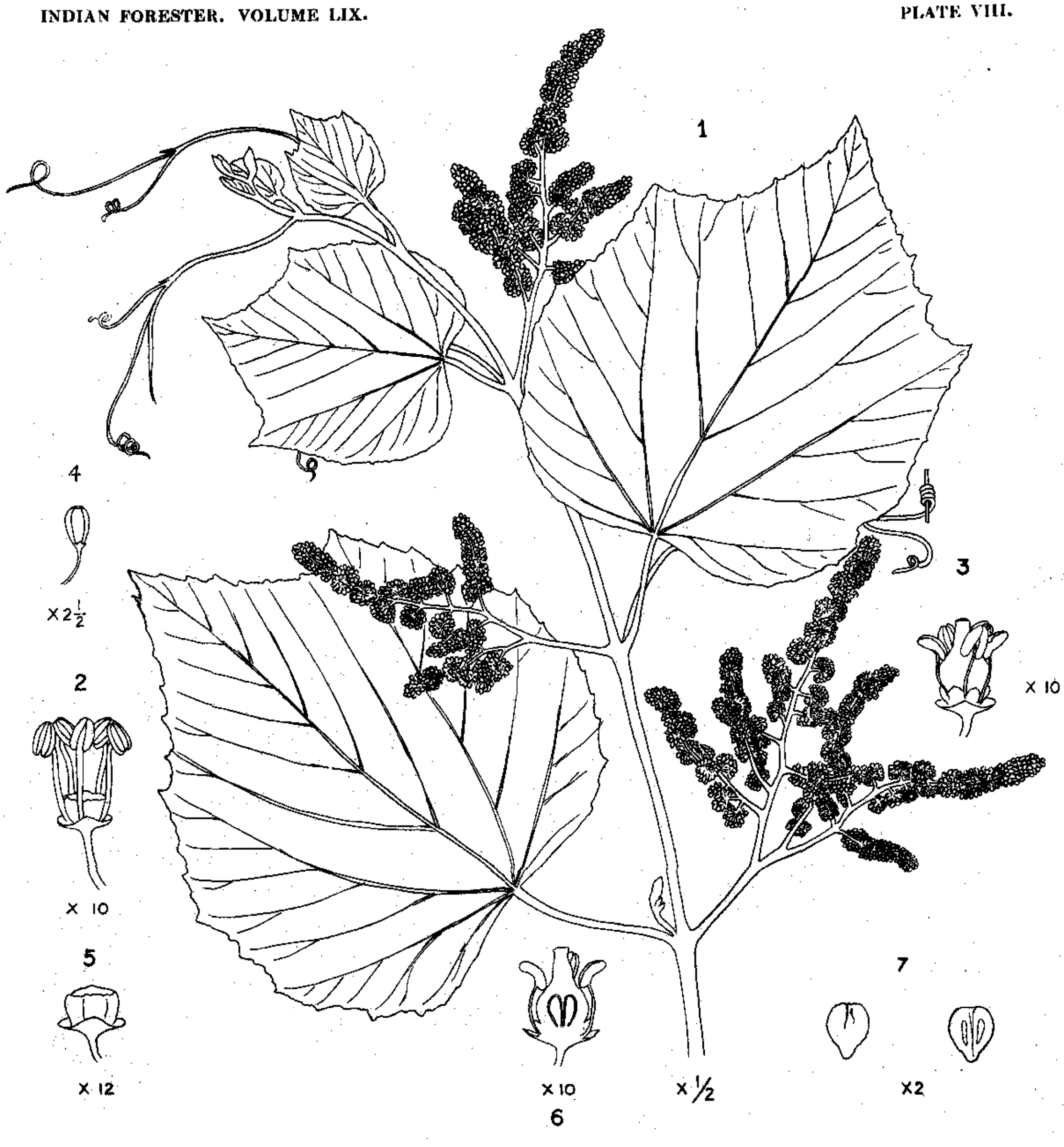
East Himalaya Cousins 22.

Assam Khasia hills Kanjilal, Clarke 43939. Jaintia hills Mann 828.

Manipur Watt 6753.

Upper Burma Collett 108, Prazer.

Madras Presidency Gamble 15932, Lushington.



VITIS JACQUEMONTII, PARKER.

Ganga Singh, del.

The specimens are not very uniform, some have much the appearance of *Vitis pedicellata* Laws. and consequently of hybrids between *V. jacquemontii* and *V. parvifolia* but the seeds are different. Without fruits I do not think it is possible to determine *Vitis* specimens in all cases, especially as hybrids between *V. heyneana* and other species may occur.

2. *Vitis jacquemontii* R. N. Parker For. Fl. Punj. ed. 2 (1924) p. 559. *Vitis lanata* Dcne. in Jacquem. Voy. Bot. p. 32, t. 36 et auct. pl. ex. parte non Roxb. *Vitis rugosa* auct. pl. non Wall.

Kashmir Keshvanand 166, Gammie, Falconer.
Hazara Inayat 19301, 19301a, 21220.
Punjab. Dalhousie Drummond 226, Chamba State Lace 1371, Parker. Bashahr State Lace 130, Kirtar Singh 77.
United Provinces Jaunsar Brandis, Gamble 20796, Smythies, Pocock. Garhwal and Tehri-Garhwal Osmaston 465, 505, 629, 672, Hira Singh 51, 332, Duthie 1462, Gamble 26634.

Mussoorie Duthie, Royle 18, Jameson. Almora and Naini Tal Davidson, Dutt, Inayat.

Nepal Bis Ram 348 Wallich Cat. No. 5994 and 5994A uterque ex parte quoad Herb. Calc.

I have observed in the field many specimens that appear to be hybrids between this species and *V. parvifolia*. As *Vitis* is polygamodioecious hybrids might well be frequent.

3. *Vitis parvifolia* Roxb. Hort. Beng. (1814) p. 18 nomen nudum; Fl. Ind. ed Carey II (1824) p. 475. *V. flexuosa* Thunb. var. *parvifolia* Planch. in D. C. Mon. Phan. V p. 348.

Wallich's Cat. No. 6005 appears to be an original of Roxburgh's presumably from a plant cultivated in the Botanic Gardens, Calcutta.

Hazara Stewart 589.
N. W. Himalaya Royle, Thomson, Cunningham, Drummond 224.
Punjab Chamba State Kurz 4302, Lace 1366, 1408, Parker.
Bashahr State Lace 145, 991, Gamble 26838, Brandis.
Sirmur Vicary.

United Provinces Dehra Dun Parker 87. Jaunsar Fischer, Gamble 22982. Tehri-Garhwal Duthie 23530, 23531, Garhwal Wall. Cat. 6005c, Falconer 355. Kumaon Strachey and Winterbottom Vitis No. 1, Davidson, Almora Osmaston 1200, Parker 2003.

Nepal Bis Ram 194, 454. Wallich 6005A.

Vitis rugosa Wall. Few plants have been more confused than *Vitis rugosa*. In Wallich's Catalogue *Vitis rugosa*, usually in the form of detached leaves, was mixed with fairly good specimens of *V. jacquemontii* showing flowers and young leaves. The leaves of *V. rugosa* resemble those of *V. jacquemontii* sufficiently closely to pass as vigorous leaves from sterile shoots. Planchon in *D. C. Mon. Phan.* V. p. 376 realized that Wallich's *Vitis rugosa* was an *Ampelocissus* and evidently saw specimens in support of this but others who have tried to verify this by reference to Wallich's own herbarium have usually been misled. There are certain points in Wallich's description of *V. rugosa* which lead one to suppose that Wallich confused two plants in his description as well as in his herbarium but there can be little doubt as to the plant he was intending to describe. *Vitis rugosa* would probably not have been confused with *V. lanata* but for the fact that this name originally given by Roxburgh to a plant of the Eastern Ghats has commonly been used for a plant of the West Himalaya *i.e.*, *V. jacquemontii*, which Roxburgh almost certainly never saw.

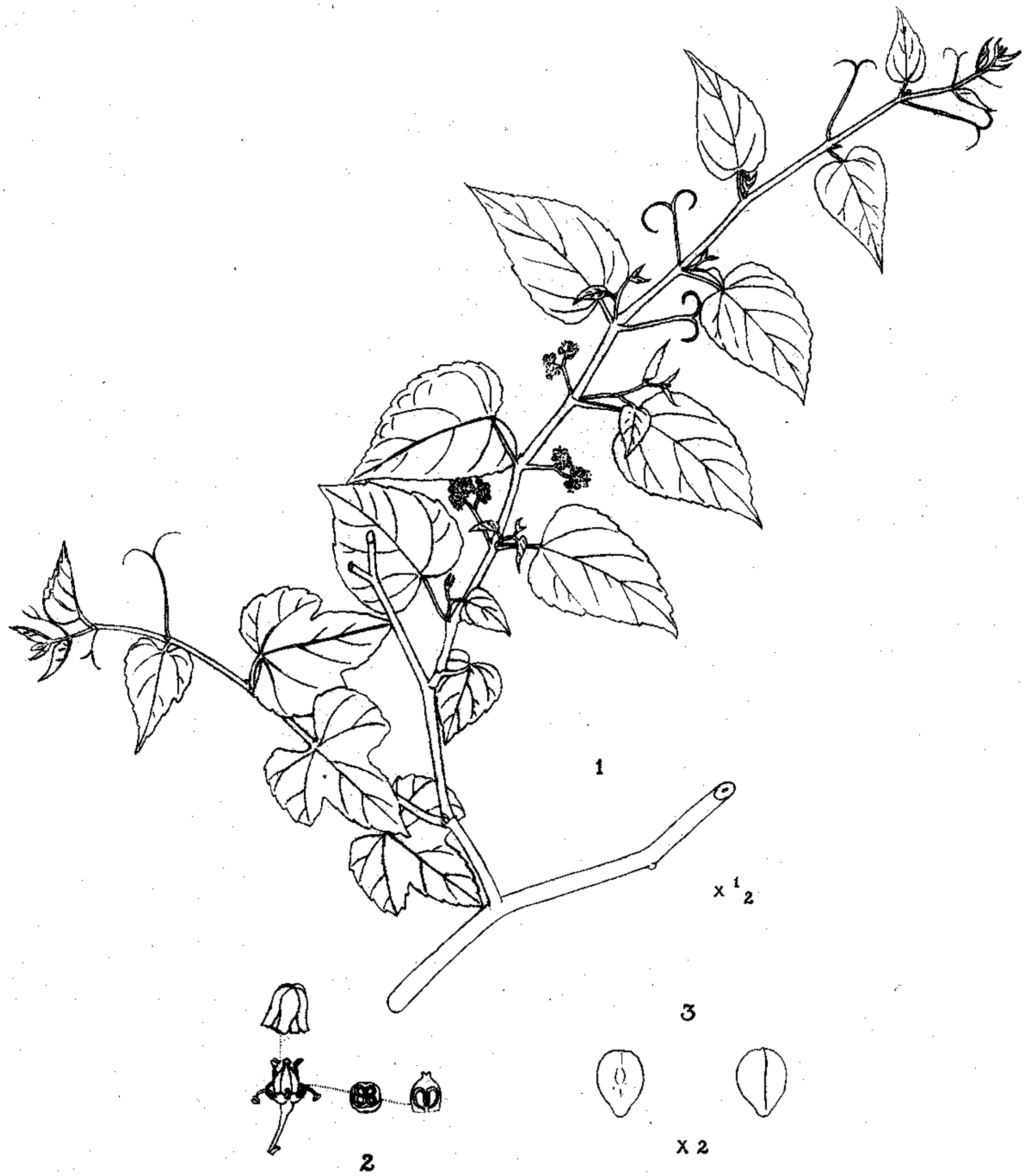
Ampelocissus rugosa Planch. in Journ. Vigne Am. (1884) p. 374, D. C. Mon. Phan. V p. 376. *V. rugosa* Wall. in Roxb. Fl. Ind. ed. Carey II (1824) p. 480. *V. macrophylla* Madden in Journ. As. Soc. Beng. 16, i (1847) p. 242 and 17, i (1848) p. 417 non Royle.

Garhwal Hira Singh 365, Osmaston 407, 464, 675.

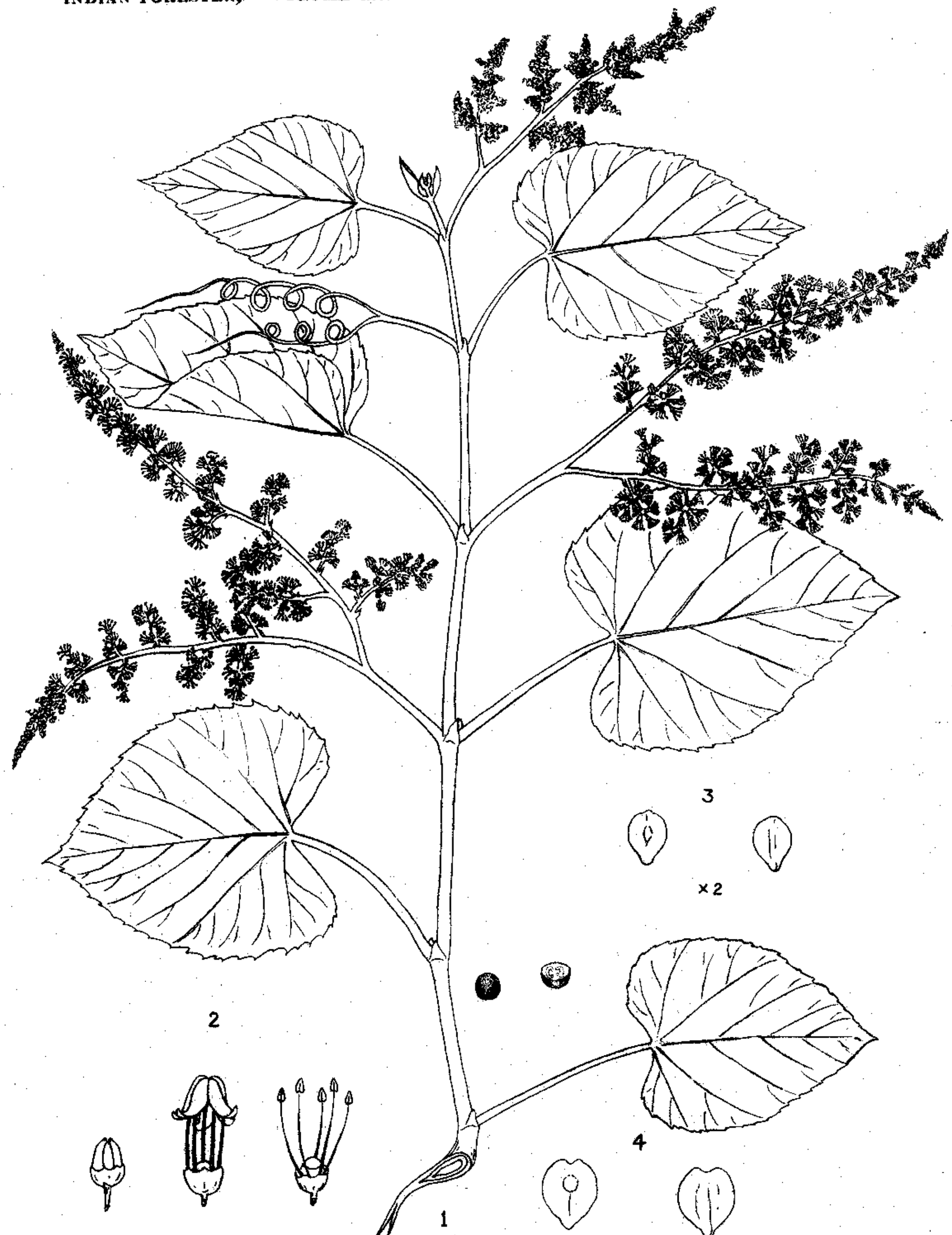
Kumaon Wall. Cat. 5994c Blinkworth, Strachey and Winterbottom Vitis No. 2, Davidson, Duthie 2790, 5440, Inayat 24299, Osmaston 700, Hole, Parker 66.

Nepal Wall. Cat. 5994, 5994A uterque ex parte quoad Herb. Calc. Bis Ram 558.

Khasia Hills Simons, Kurz 512, Clarke 38508, 44308, Mann, Kanjilal 2388.



VITIS PARVIFOLIA, ROXB.



VITIS HEYNEANA, ROEM. & SCHULT. (*Vitis lanata, Roxb.*)

A recent and accurate description of this species will be found in Osmaston, *For. Fl. Kum.* p. 115. I have cultivated it for 9 years in a flower pot in Dehra Dun. It has a thick tuberous root which sends out shoots towards the end of the hot weather ; these die down again after the rains. I have only seen it flower once in Dehra and it has never ripened fruit.

Explanation of Plates.

I. *Ampelocissus rugosa* Planch.—*Vitis rugosa* Wall. Flowering shoot from Parker 66. Seed from the same locality.

II. *Vitis jacquemontii* Parker.

III. *Vitis heyneana* Roem. and Schult. Roxburgh's original drawing of *V. lanata,* the seed added, the smaller seed from Thomson's Sikkim specimen the larger seed from Kanjilal 2298.

IV. *Vitis parvifolia* Roxb. Roxburgh's original drawing, the seed having been added from a specimen of Drummond.

DEHRA DUN :
14-10-1932.

RECENT CHANGES IN MANAGEMENT IN HIMALAYAN CONIFEROUS FORESTS WITH SPECIAL REFERENCE TO THE SHELTERWOOD COMPARTMENT SYSTEM.

By H. M. Glover, I. F. S.

[The following extracts are from a paper read by Mr. Glover at the 1931 Punjab Forest Conference, and should be of interest to all provinces in which shelterwood working plans have been introduced. Parts III and IV deal with the detailed calculation of the yield under both shelterwood and selection systems, and they have not been reproduced; those interested should refer to the printed *Proceedings*, published by the Superintendent of Government Printing, Lahore.—Ed.].

PART I.

EARLY HISTORY AND SYSTEMS OF MANAGEMENT.

1. *Introduction.*—Recent changes in forest management in the Punjab form an interesting study and have already been dealt with by the writer in two papers—(*a*) "Two modern working plans for coniferous forests of the Punjab Himalayas," *Indian Forester*, February 1928, and (*b*) on "The best method of calculating sustained annual yield," pages 266 to 271 of the Proceedings of the Third Silvicultural Conference, Dehra Dun, March 14th to 20th, 1929,—paper (*ii*). A reference to these two papers is invited.

Much of the following argument has already appeared in these two papers, and is repeated at the suggestion of the present Conservator in charge of the Working Plans branch, in order to render this paper self-contained. I therefore describe briefly the past history, the composition and the character of the Punjab Himalayan coniferous forests and the special difficulties which have been encountered in the application of the shelterwood compartment system of management.

2. *Locality.*—The forests lie in the Himalayas on slopes which vary from moderate to precipitous but are generally steep and predominantly consist of coniferous trees except in the damper nullahs and at higher elevations. The soil is derived mainly from crystalline or metamorphic rocks in the inner ranges and from sedimentary Tertiary strata in the Outer Himalaya and is admirably suited to the growth of conifers. The rainfall varies in different localities, but on the whole is suitable for the growth of mesophytic varieties of trees such as the conifers.

3. *Early history.*—Before the British occupation forest fires raged more or less uncontrolled and had the effect of destroying the younger trees with the result that the forests were understocked and consisted largely of old trees of huge size occasionally forming compact woods but more often scattered singly or in groups over wide areas. Shifting cultivation was common and as the fertility of the soil was exhausted, the fields relapsed to jungle ; wars and internecine strife were common and land went out of cultivation and

became covered with trees; a similar result occurred when the cultivated lands were first assessed to a cash revenue as the villagers abandoned the more unproductive fields.

The civil authorities realised the destruction done to the forests which was accentuated by indiscriminate felling for timber for the railways and for the new cantonments, and the Hill Forest Conservancy rules of 1855 were introduced with a view to conserve the remains of the forests. All species had suffered from fire, but the *chir* pine owing to its thick fire-resistant bark survived in comparatively homogeneous though somewhat open crops of mature trees, and the fir forests with a damp soil covering survived as compact blocks of high mature forest. The blue pine trees were usually scattered at wide intervals, but the deodar often occurred as high forest in temple groves of varying extent, sacred to the local deity.

With fire protection, with the abandoning of the practice of shifting cultivation and with the prevention of indiscriminate felling, reproduction of the conifers took place in the neighbourhood of the mature trees. This naturally came in slowly and in the moister tracts had to face competition by weeds and bushes; nevertheless the forests became better stocked, and with an increase in the stocking the factors of locality improved and the ground retained more moisture. In the tracts where rainfall was heavy there was a tendency for bushes to occupy the ground instead of the more mesophytic conifers, and after long years of successful fire protection it was found that conifer regeneration did not appear as rapidly or to the same extent as shortly after protection had first been introduced. As security increased flocks and herds multiplied and in many localities prevented the growth of seedlings, and over wide tracts of the Outer Himalaya grazing is still a factor of prime importance in promoting the disappearance of the forest. The traders had often clear felled the forests with the object of bringing the maximum amount of timber down slides which were often constructed at considerable expense: the forests on the more moderate slopes had suffered most, particularly the deodar high forest, and the soil eroded badly with the result that these lower slopes are bare to this day, particularly in the dry zone of the Inner Himalaya, but also in the moist tracts where dense brush appeared.

From about the sixties and seventies when the new Forest Department first took control, fellings were severely curtailed and consisted of the removal of large mature trees over young growth according to simple working schemes. In Upper Bashahr, however, where there was a large stock of mature high deodar forest and logging was practised, many of the mature forests were gone over in shelterwood fellings and a certain amount of artificial re-stocking was attempted. The passage of the logs churned up the soil with the result that reproduction was often profuse. The more remote precipitous forests were not, however, worked.

4. *The first working plans.*—In the eighties the first working plans were made, generally on simple lines, and prescribed the removal of a limited number of mature trees. Sir Dietrich Brandis evolved a simple system, called the Indian Selection system, whereby the fellings were limited to mature trees and the yield was calculated at a maximum figure based on the replacement of the mature trees by those of the younger age classes.

This system prevailed till 1911 when the Chamba plan was revised on the lines of the group system. The Rawalpindi working plan (Jerram, 1915) followed and was based on the shelterwood compartment system. The Kulu plan (Trevor, 1919) first applied the shelterwood compartment system of management to all conifers.

5. *Disadvantages of the Indian Selection System.*—The selection system possessed certain disadvantages, chief of which was the diffusion of operations which rendered control difficult and did not allow for the concentration of outturn. The forests often lie at the heads of side streams down which timber has to be floated, or on shelves above precipices down which scantlings are carried by ropeways. A large outturn is required in order to make slides and ropeways profitable. This was allowed for by arranging that selection fellings should go over each forest in a cycle generally of 15 years. The first fellings offered no difficulty but at subsequent fellings it was found both that regeneration had not come into the extent expected and that second class trees left to form part of the future merchantable crop had not developed. These second class trees were found to be of full rotation

age ; but either through suppression or bad situation and shallow soil were often incapable of development. With fellings limited to the removal of isolated mature trees as in the Indian Selection System it was found to be impossible to follow up fellings by cultural operations. At the end of the first felling cycle some parts of each forest in the whole working circle were under regeneration ; consequently the preparation of a proper seed bed was perforce neglected. This had not been of any great importance so long as the forests were worked in log, but with the change to extraction in the form of scantlings, which were converted *in situ* about the beginning of the century, the forests became littered with refuse which clogged the seed beds and effectually prevented regeneration. Regeneration was not obtained to the extent desired and the scattered felling areas rendered the control of grazing difficult. In mixed woods it was found that the selection system favoured the spread of the more shade bearing species, satisfactory in the deodar-blue pine mixture, but objectionable where spruce and fir regeneration invaded deodar areas. In *chir* forests, as the *chir* is a strong light demander, the results were poor. Universally it was found that there was a marked tendency for the young woods to form homogeneous crops on all moderate slopes, and that management under the selection system checked this desired effect. Other drawbacks were that trees grown under the selection system produced low branched crowns, which hindered the development of compact groups of younger trees.

6. *The Selection System modified.*—At first attempts were made to form small gaps in deodar forests (Kulu working plan,—Fisher, 1897), but it was found impossible subsequently to extend groups of regeneration by reason of the general immaturity of the surrounding woods : in 1911 a modified group system, consisting of isolated clear fellings at intervals was adopted in deodar forests in Chamba, but was later abandoned in favour of the shelterwood system as regeneration was not generally obtained : about the same time in the Pabar a similar system of fellings in isolated gaps in blue pine woods was tried and proved useful in facilitating the artificial introduction of deodar but was subsequently abandoned in favour of the shelterwood system. In Upper

Bashahr the selection system had been modified as the mature trees often occurred in patches of considerable extent and provision was made to open them in shelterwood fellings—Hart, Sutlej Valley Working Plan, 1904. Regeneration was obtained, but as each forest in turn was worked on a 15-years cycle, it became increasingly difficult to follow seeding fellings by cultural works and in particular the removal of refuse was neglected. Generally in hill forests the selection system was modified about 1912 and 1913 in favour of marking first and second class trees in clear felled gaps, miscalled the group system, but the results were not satisfactory and this system was soon abandoned.

7. *The first working plans on the Shelterwood Compartment System.*—Meanwhile Trevor in Kulu had carried out experiments with shelterwood fellings in deodar, *kail* and *chir* forests. The results as regards regeneration were most encouraging. In Rawalpindi Jerram prepared a working plan for the *chir* forests and applied the shelterwood compartment system which resulted in the establishment of profuse regeneration. In the Kulu Working Plan (Trevor, 1919) for the mixed deodar and blue pine, the *chir* and the spruce and fir forests the shelterwood compartment system was prescribed and it may be said at once that the results as regards regeneration have been excellent.

Why then is there any necessity to modify the shelterwood compartment system in the Punjab Himalayas ?

PART II.

MODIFICATION IN THE SHELTERWOOD COMPARTMENT SYSTEM.

8. *General.*—Now a working plan must serve four main objects :—

(*a*) the obtaining of complete regeneration ;

(*b*) the satisfaction of local rights, particularly those to timber and grazing ;

(*c*) the production of timber of dimensions and quality most suited to the market demand ;

(*d*) a sustained annual yield subject to no great fluctuations and with a tendency to rise in each succeeding period or sub-period.

Shelterwood fellings are admirably suited to the regeneration of deodar, *kail* and *chir* in all forests of moderate slope within the stable zones of these species. They have been carried out on a small scale in the spruce and fir forests in Kulu, and in the opinion of the writer are suitable, provided only that the cost of preparing and maintaining a clean seed bed is not prohibitive by reason of the immense accummulation of refuse from conversion. Perhaps the most important advantages of the shelterwood system are the facility afforded to the burning of refuse from conversion and the preparation of the seed bed, the ease with which the mixture by species can be regulated and the introduction artificially of more valuable species. The young woods form comparatively homogeneous crops which can be thinned and tended with ease. Thus wherever the slope of the hill is not too steep or where conditions are not particularly adverse, *e.g.*, at the limits of altitude of the species or on particularly hot and dry slopes, the first condition which may be termed the silvicultural suitability of the system to the regeneration of the species has been attained.

9. *Inapplicability to forests on steep slopes.*—On slopes up to 30 degrees there is no real difficulty in applying a shelterwood system ; on slopes up to 35 degrees comparatively homogeneous crops can still be grown ; but from 35 degrees upwards the slope is too steep for the formation of homogeneous woods. Trees grown at intervals develop side branches, and as the slopes become more rocky and precipitous the type of forest becomes more and more irregular and homogeneous woods cannot be produced.

One of the most important requirements is the maintenance of the soil fertility. The selection system never involves the breaking of the canopy over large areas at one time and undoubtedly maintains the fertility of the soil to a maximum degree : a shelterwood system, on the other hand, involves a more or less heavy opening and the soil is exposed to the sun and wind with resulting desiccation and loss of fertility. This is not of great importance on moderate slopes, provided that the interruption of the canopy is not too great ; indeed it is sometimes necessary to reduce the factors of the locality temporarily, particularly the moisture content of the soil, in order to

obtain coniferous regeneration. On steep slopes, on the other hand, any comparatively severe removal of the cover is followed by erosion of the surface soil.

The first modification of the present extensive application of the shelterwood compartment system is, therefore, the exclusion of all extensive very steep areas. It is impossible to exclude all steep slopes and rules are modified so as to allow of marking on selection lines on such comparatively small steep areas as are included in the shelterwood circle.

10. *Shelterwood Compartment System not suitable at extreme altitude limits of species.*—Similarly towards the limits, both higher and lower, of its zone a species regenerates only slowly and sporadically. Consequently irregularity becomes a marked feature of the forest and regeneration is difficult to obtain and the period of establishment of the young crop is excessive. Here too management must conform to selection or protection principles. In fact no attempt is made to force forests into complete uniformity on areas where Nature intended the crop to be irregular.

11. *Irregularity caused by changes in soil quality.*—From now onwards we will presume that we are dealing with the application of the system to species growing on moderate slopes and within their natural and optimum habitat. We have seen that regeneration is being obtained profusely; consequently our woods of the future will, under present conditions, be approximately even aged within each coupe: in other words we shall obtain a regular series of age classes. So far so good; but what we shall not obtain is a regular series of size classes for the reason that the terrain is so irregular that spurs with shallow soil alternate with hollows where the soil is deep and fertile. Consequently the quality of the locality changes rapidly and it is common for areas of 1st, 2nd and 3rd quality to lie in close juxtaposition on which the rates of growth vary within wide limits. Added to this condition is the variation in aspect: on southerly slopes the soil is dry and unproductive in marked contrast to the soil on northerly aspects. Again our forests range across zones in which the difference in altitude may amount to 3,000 feet or more. We thus

have no homogeneity of quality throughout the forest and on soils of each quality class the rate of growth of the trees is very different. On good soils the trees will reach exploitable size many years before those on poor soils, and although we shall have succeeded in growing even aged woods there is no certainty whatever that the trees will be of even size: indeed the opposite is inevitable. We shall return to this matter later when considering the policy of growing woods in which a certain amount of irregularity forms a permanent feature of management.

12. *Satisfaction of rights.*—It is not necessary here to deal fully with the satisfaction of rights to grazing and timber. Under the shelterwood compartment system felling series must be formed according to grazing requirements in order to facilitate the control of grazing as in the Kulu and Kangra plans. The satisfaction of annual demands for timber by right-holders is, however, difficult under the shelterwood compartment system, as is now being experienced in the Pine Working Circle in Hoshiarpur.

13. *Protection from fire.*—One very disturbing factor is the recrudescence of incendiarism and the exposure of the young woods to fire. The young crops are so dense under a shelterwood system of management that the grazing is not likely to be of any great value once the woods have reached the pole stage and will be less than prevailed under the open and irregular woods of the past. Opinions are requested as to whether it is possible to bring the woods to maturity in the face of possible or even probable opposition by graziers. In *chir* forests the retention of patches of poles and advance growth in regeneration areas is of advantage as such poles are immune from the effect of all but very severe fires and it is possible to burn the grass under control in the cold weather.

14. *The production of timber most suited to the market demand.*—The main demand for our timber is from the railway for sleepers of large cross section in order to carry the heavier rails and locomotives now used. Deodar sleepers may not contain more than 10 per cent. sapwood, but sapwood is permitted in sleepers of other species. Firewood is generally quite unsaleable.

The diameter of the exploitable tree is about 30 inches for deodar, (the exploitable size of 24 inches diameter adopted in some recent plans is now considered to be too low for railway requirements), and 24 inches to 30 inches for other species. It is essential in shelterwood plans to see that P. B. I. is so chosen that the average size of the trees to be felled approaches closely to the exploitable size. The market for small size timber fluctuates ; a limited quantity of small scantlings can be sold, but the market is easily flooded. The price increment as the cross section increases is considerable, and although there is a limited market for small scantlings, we must ensure that our main yield is in the form of trees suitable for supplying the main market demand for scantling of large cross section. It may be taken that a tree of 18 inches to 24 inches diameter is fit only for conversion for the general market and not for the railway : from 24 inches to 30 inches it is fit only partly for the conversion of large scantlings ; that above 30 inches the tree is entirely suitable for both the general market and the railway. Trees of less than 18 inches diameter yield only small scantlings which sometimes are saleable at very low prices.

It is by no means certain that we can maintain a high exploitable diameter under the shelterwood system such as is required for the production of railway broad-gauge sleepers : we may eventually have to confine the production of the largest size trees to the selection circle and supply timber from the shelterwood circle to the general market. As the rotation under the shelterwood system requisite to produce very large trees is of inordinate length we cannot at present come to a definite decision on this point, and this matter is left over for future consideration.

15. *Effect of marketable product on management.*—Our woods have been managed on the selection system for over half one rotation : as a consequence they are irregular and all age classes may occur in each forest. Consequently the greatest difficulty is often experienced in finding compact blocks of forest ready to be regenerated.

The first shelterwood plans aimed at complete regularity over large areas and prescribed the regeneration of woods in which the

trees were of more than 12 inches diameter. The compartments, or units of management, were of large extent as compared with those of Europe, which was necessary in order to allow of sufficient concentration of fellings and tending operations, and many compartments allotted to P. B. I. contained, in addition to mature timber, crops of poles of considerable extent. Sometimes the working plan officer prescribed the regeneration of these woods, sometimes their preservation to form part of the future crop. Generally whatever were the silvicultural prescriptions the volume of poles above 12 inches diameter was included in the prescribed yield, and sometimes there was a discrepancy between the silvicultural prescriptions and the assessment of the yield.

The executive officers were confused by this uncertainty : pole woods were sometimes left as part of the future crop but more often were cut over in seeding fellings. This was soon found to be objectionable for at least two very good reasons—(*a*) the produce was unsaleable and (*b*) the standing trees were too immature to produce seed. It was found that the market was apt to be flooded with small material for which there was little demand and much of the timber from immature trees was allowed to rot on the ground or was sold at a very small profit.

16. *Terminology and the size of the compartments.*—It appears that terminology had some share in causing this misconception : the system was named the shelterwood compartment system, and as in Europe the whole compartment was regenerated. But in Europe the unit of management, the compartment or the sub-compartment, is very small indeed, often a few acres and is so chosen as to exclude immature woods. In India this was not possible. Had the system been named the shelterwood system and had all officers realised that complete uniformity in the young crop throughout the compartment was neither attainable nor desirable, groups and patches of young poles in the block under regeneration would not have been felled unnecessarily. It was recognised that conversion from the selection to regular methods of management would involve sacrifice of immature material

in the first periodic block, but in actual practice this sacrifice was entirely vicarious: the immature trees were felled and a profit was often made on their conversion; but they were felled when they were immature, and the effect of their loss will be felt in the revenue returns not immediately but in the future.

17. *Fellings outside the first periodic block.*—The fellings outside P. B. I. of the first plans were regulated by silvicultural principles. In some plans they were virtually forbidden and thinnings amongst the young trees were prescribed. In operations under the early plans, however, many mature trees were cut during thinnings, and silvicultural prescriptions were sometimes so misinterpreted as to involve the removal of most of the mature trees standing over immature crops during the first thinnings cycle. The mature and semi-mature trees outside P. B. I. suffered severely with the result that the working capital of the forest as represented by its merchantable timber was unduly diminished. It became necessary to regulate the rate of removal of exploitable trees outside P. B. I. by volume control as well as by silvicultural rules.

18. *Silviculture in its relation to management.*—There appears to have been some confusion in thought between silviculture and management. Silviculture deals with the means taken to regenerate particular forests and to tend growing woods, and each unit is dealt with piecemeal. Management deals with the forest as a whole, and although good management is based and is absolutely dependent on good silviculture, it does not follow that it is possible to afford the optimum silvicultural treatment to each unit of management, the compartment or the sub-compartment as the case may be, as the treatment to which each compartment is subjected depends not on itself alone but on its relation to other units, which together form one composite whole. The objects of management are defined in the working plan, which prescribes the treatment to which each unit as part of the whole estate shall be subjected in order that these objects shall be attained.

19. *Conclusions.*—(*i*) It has been found to be impossible so to reduce the size of the compartment or sub-compartment, *i.e.*, the area

unit of management, as to ensure that only one age class or quality class is allotted to each unit. Consequently the term shelterwood compartment system is a misnomer, and it would be advisable to change the name of the system to the " shelterwood " system or perhaps preferably to the " Punjab shelterwood " system in order to avoid confusion with European classification.

(*ii*) It is necessary to confine the shelterwood system of management to types of forest and terrain to which it is suited. It is not applicable to extensive stretches of very steep or precipitous ground, and where the slope exceeds 35 per cent. the shelterwood system should not be adopted. No attempt should be made to force forests into a preconceived system of management to which they are by nature unsuited.

(*iii*) A certain amount of irregularity in the young crop must be recognised as a permanent feature of management. Well grown compact groups of poles must be retained as part of the regeneration whenever they are of such small size or contain such branched trees as to be of small value for the ultimate production of timber.

(*iv*) Isolated well grown poles and immature trees with high well developed crowns must be left in areas under regeneration till the end of or even beyond the first period in order that they may put on increment and reach exploitable size.

(*v*) The yield of merchantable timber must be controlled by volume throughout the working circle in order to ensure that there shall be no undue reduction in the capital stock of the forest as represented by mature trees and trees approaching maturity.

(*vi*) When the configuration of the ground is such as to entail management on the lines of the selection system, this system is introduced, but with modifications so as to allow of the regeneration under a shelterwood of such small patches of mature forest as are met with. A compromise is effected suitable to the actual factors of the locality and the distribution of the growing stock.

PRELIMINARY CHEMICAL EXAMINATION OF *DODONŒA VISCOSA*, LINN.

BY T. P. GHOSE, ASSISTANT, CHEMICAL BRANCH, FOREST RESEARCH INSTITUTE.

Dodonœa viscosa, Linn. (Syn. *D. angustifolia*, Willd. and *D. diodea*, Roxb; Ver. *sanatha*, *mendar* (Punjab), is a gregarious evergreen shrub, or small tree, growing plentifully in the drier regions of the North-West and Central India as well as in the Deccan (Brandis Ind. Trees, p. 186), and is very commonly grown as a hedge plant since it is not browsed by cattle. The natural aversion of animals to this plant suggested in it the presence of some constituents distasteful to them and it was thought that these constituents might possess some medicinal properties. Kirtikar and Basu (Ind. Med. Plants, Part I, p. 367) mention the medicinal properties of the leaves of this plant as follows; "Lindley says the leaves are used in baths and fomentations. It is believed that the powdered leaves applied over a wound will heal it without leaving a white scar. It is applied in burns and scalds. Said to be useful also in rheumatism (C. J. Peters in Watt's Dictionary). Said to possess febrifuge properties. In the Punjab, it is used in snakebite. For this purpose, the leaves are bruised and applied to the bitten part; juice of the leaves is also given internally (B. D. B.)." Since no information is available about the chemical constituents of this plant, it was thought desirable to examine it chemically with a view to finding some constituents of economic value, medicinal or otherwise.

(A) *Examination of the leaves.*—These were collected partly from the hedge grown round the Insectary, and partly from the experimental plantation of the Silviculturist, Forest Research Institute. The leaves possess an astringent and slightly bitter taste and a rather disagreeable odour. Completely air dried leaves containing 10—12 per cent. of moisture were finely powdered and successively extracted with various solvents. The extracts thus obtained were dried, weighed and further analysed.

Analysis of the air-dried leaves.

Solvent.	Extract per cent. on air-dried leaves.	REMARKS.
i. Petroleum ether ..	3·2	Dark green wax and fats.
ii. Ether ..	7·3	Resinous and acidic substance, alkaloidal substance, etc.
iii. Chloroform ..	1·8	
iv. Alcohol ..	18·2	Resinous and acidic substance, red colouring matter, tannin and glucocidal substance, etc.
v. Water ..	9·7	Tannin, gummy and pectous matter, sugars, etc.

The ether and chloroform extracts were mostly soluble in 70 per cent. alcohol. These were dissolved in glacial acetic acid and precipitated with water. The precipitate (*i*) was extracted with sodium carbonate solution (10 per cent.) filtered and extracted with chloroform. Three substances were thus isolated—

(*a*) a neutral resin, extracted by means of chloroform (3·8 per cent. of the leaves) ;

(*b*) a dirty dark green acidic resin (2·84 per cent. of the leaves) ; and

(*c*) a reddish brown amorphous acidic substance which gave deep yellow colour with alkalies (0·8 per cent. of the leaves).

The dilute acetic acid solution (*ii*), left after removal of the resinous and acidic substances, was examined for alkaloids, traces of which were detected.

The alcoholic extract was found to consist of 12·3 per cent. (on leaves) of solubles and the rest 5·9 per cent. insoluble in water. The portion soluble in water showed the presence of tannin and the insoluble portion was found to consist mainly of colouring matter and resins, etc.

The aqueous extract showed the presence of a glucocidal substance, tannins, gums and pectous matter.

Preliminary examination having established the presence of an alkaloidal substance, a small amount of glucocides and an amorphous acidic substance, attempts were made to isolate these in a pure condition.

(*i*) *Alkaloid.*—For isolation of this, finely powdered, air-dried, leaves were extracted with ether-chloroform-ammonia mixture and the crude alkaloid was finally separated on extraction with chloroform in the usual manner. The alkaloid was obtained as a glassy mass in 0·02 per cent. yield and all attempts to crystallize it were unsuccessful.

(*ii*). *Glucocidal substance.*—This was isolated from the alcoholic extract (cold percolation) of the leaves by precipitation with basic lead acetate (after removal of tannins) and subsequent extraction with ethyl acetate of the lead-free dry aqueous extract. Only a very small amount of an amorphous hygroscopic substance was obtained. This, on hydrolysis with 5 per cent. sulphuric acid, gave a brown resinous, amorphous substance, soluble in benzene and ether. The acid filtrate on being neutralized reduced Fehling's solution, showing the presence of sugars.

(*iii*). *Acidic substance.*—Isolation of this was accomplished by extraction of the leaves with boiling alcohol. After complete exhaustion of the leaves, the alcoholic extract was filtered and the alcohol removed by distillation. It was then extracted with sodium bicarbonate solution (10 per cent.) From the clear bicarbonate solution, the acids were precipitated with dilute acetic acid. These were dried and extracted with benzene in a soxhlet apparatus. On removal of the solvent, the residue was dissolved in ammonia and the acids again precipitated with dilute acetic acid. The acids, thus purified, were found to consist of two substances ; one of which gave a barium salt soluble in water and the other gave a very sparingly soluble barium salt. The first acid, regenerated from its barium salt, was a bright brown amorphous substance, softening and melting with frothing between 123°—126°C. The second acid was also amorphous but of a deep brown colour. It softened at 145°C and melted with frothing at 155°C. Both the acids developed deep yellow colour with alkalies.

(*iv*) *Tannin.*—The leaves were analysed for their tannin content by the standard chromed hide powder method.

	Per cent.
Moisture	9·10
Tannins	5·98
Non-tans	24·10

In view of the low tannin content and the very high percentage of non-tans, the leaves are, for all practical purposes, useless as a tanning material.

(B) *Examination of the bark.*—It is a general observation that while the leaves of a plant contain only a small amount of an alkaloid, the bark usually contains a much greater quantity of it. The bark of *D. viscosa* was, therefore, examined with the following results :—

Analysis of *D. viscosa* bark containing 10·3 per cent. of moisture.

Solvent.	Extract per cent. on air-dry bark.	REMARKS.
Petroleum ether ..	1·75	Fats and wax.
Ether ..	0·97	Resins, etc.
Alcohol ..	5·55	Resins, tannin, etc.
Water ..	7·30	Tannin, sugar, pectous bodies, etc.

The bark, also like the leaves, was found to contain only a trace of an alkaloid and therefore cannot be expected to possess any medicinal value. It contained 5·8 per cent. of tannin and 5·3 per cent. of non-tan and can, therefore, at best, be classed as an inferior quality tanning material.

Summary.

(*i*) *Dodonæa* leaves contain 0·02 per cent. of an alkaloid and also a small amount of a glucocide.

(*ii*) It contains a fair amount of a neutral and an acidic resin and also amorphous acidic bodies.

(*iii*) The medicinal properties of the leaves are probably due to the alkaloid and the glucocide which it contains.

(*iv*) The resinous and acidic substances may also possess some physiological properties but this needs investigation.

(*v*) The leaves and the bark are practically useless as tanning materials.

Attention to this subject was drawn by Mr. R. N. Parker, I.F.S., to whom I feel indebted.

HARDWICKIA BINATA COPPICE REPRODUCTION.

BY TARA SINGH, I. F. S.

The Divisional Forest Officer, Nimar, Mr. Sodhi, laid out two experimental plots of about two acres each in Bhojwa block of Khandwa Range during May 1930. The objects were to study the technique of *anjan* coppice reproduction at varying stump heights and girths and to observe the effect of hot weather firing on the production and development of coppice shoots. Accordingly trees of different girths were selected and felled at different heights above ground and one plot was fired at the end of the hot weather. The detailed observations were carried out by the local staff in July 1931 and the data were examined by the Provincial Silviculturist. The results so obtained are summarised below :—

Local Anjan Plot No. 1 (*Unburnt*).
Observations of July 1931.

Girth classes (Inches).	Total No. of Stools.	Total No. of Shoots.	Average No. of Shoots per stool.	Average Height (Inches.) Minimum.	Average Height (Inches.) Maximum.
	Stools cut 1′ above ground.				
0—12 ..	4	48	12	10	18
12—24 ..	36	424	12	8	18
24—36 ..	6	44	7	6	17
36—48 ..	1	2	2	4	14
Over 48 ..	2	13	6	2	6
Total ..	49	531	..	30	73
Average ..	..	..	11	6	15
	Stools cut flush with ground.				
0—12 ..	7	133	19	8	18
12—24 ..	*36*	*752*	*21*	*11*	*23*
24—36 ..	7	75	11	10	19
36—48 ..	1	3	3	10	16
Over 48 ..	..	..	..	..	..
Total ..	51	963	..	39	76
Average ..	..	..	19	10	19

Local Anjan Plot No. 2 (*Burnt*).
Observations of July 1931.

	Stools cut 1′ above ground.				
0—12 ..	1	10	10	24	41
12—24 ..	8	113	14	16	31
24—36 ..	17	131	8	14	27
36—48 ..	6	15	3	11	14
Over 48 ..	2	1	..	12	..
Total ..	34	270	..	77	113
Average ..	..	..	8	15	23

The following general, but necessarily tentative, conclusions may be derived from the above statements :—

1. On the whole the 12″—24″ girth class has produced the largest number of shoots per stool in all the three cases, the production of shoots in other classes being in the order : 0″—12″, 24″—36″ and 36″—48″ girth classes.

2. In the *unburnt* plot *anjan cut flush with the ground* has on the average produced a larger number of coppices hoots, but with a greater variation in heights than the stools *cut one foot above the ground level.*

3. The *burnt* plot demonstrates that *arjan cut one foot above ground* has on the average given out a smaller number of coppice shoots per stool than that in the *unburnt* plot, but the range of heights of the shoots is very much bigger in the former than in the latter.

[NOTE.—It is not easy to derive correct conclusions from field data including two or more independent variables—here girth, number and height—without statistical analysis. In view of the interest taken in this question of the coppicing of *anjan*, the data of the experiments which formed the basis of the discussion in 1929 and 1930 volumes of the *Indian Forester* are being examined and may form the subject of a further note.—H. G. Champion, Silviculturist.]

THE ERADICATION OF *LANTANA* WITH ELEPHANTS IN THE MELGHAT DIVISION, C. P.

BY V. K. MAITLAND, I. F. S.

General.—For the benefit of other Forest Officers faced with the problem of having to eradicate old *Lantana* in specially protected areas, where labour and funds are very limited, but where the services of elephants can without much difficulty be provided, I venture to contribute the following low-brow notes to this highly scientific journal. My labours in combating the dense patches of *Lantana* which infest the Chikalda Plateau have, this rains, not been distinguished by the acquisition of any valuable technical data, but

have been marked by the development of a certain low cunning in dealing with the pest, by methods which may perhaps be usefully tried elsewhere. For what it is worth then, the way in which the use of elephants in the eradication of *Lantana* in special areas of this division began and has been continued, are described in the section headed " Notes " below. A few words on the less practical aspects of the subject may however first be given :—

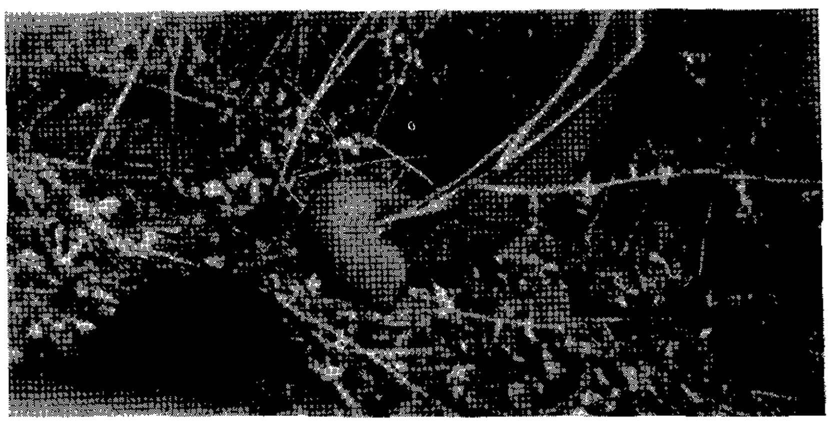
I shrink from the prospect of becoming embroiled in the usual discussion concerning depreciation, interest on capital outlay, etc., etc., for which I fear the Chief Conservator is pining already. The issues are too complicated. I only wish to assert that on *Lantana* work in the rains, a C. P. Forest Department elephant may be guaranted to earn its keep, which is more than it does kicking its heels about in the average divisional headquarters or in some adjacent jungle. The concentration of say six divisional elephants in one locality enables them to be fed more cheaply. They have the benefit of one another's company, advice, and example—and do not indulge in the wrangling, jealousy, scandal, and, shall we say, back-biting which are the outstanding features of the gatherings of elderly virgins of other mammalian orders. For the average C. P. elephant leads a solitary life deprived of the usual and recognised amusements of its kind and tends to become narrow minded and parochial in its outlook. The free interchange of ideas inseparable from little pachydermatous gatherings such as the one recently staged at Chikalda adds variety to a dull existence. The Chikalda course may claim to confer benefits intangible (unrecognised by commercial accounts), benefits social and perhaps intellectual. These benefits are however incidental only. The Chikalda *Lantana* course (for approved only) has been a serious matter, and came as a surprise to the participants. One or two elephants which strolled with middle-aged levity light-heartedly up the hill, the holiday spirit strong upon them, returned to their divisions in October in more sober mood having been awarded a " lower standard certificate " only ! One must however refrain from moralising.

As regards the illustrations which have been sent with these notes I would remind my critics that eradication of *Lantana* is least difficult

and most impressive when performed in pouring rain. These characteristics are however not those of photography. Here it may be stated that the full beauty of the operation can only be reproduced by the cinema. I can imagine few more exquisite displays of the poetry of motion, few more realistic demonstrations of the triumph of mind over matter, than a cinema show in slow motion of the back aspect of an elephant engaged in *Lantana* eradication. A line of six elephants with noses well down to it in a dense mass of *Lantana* presents from the rear a serried rank of determined posteriors , the awful majesty of which is not a whit reduced by a certain rugged simplicity of individual outline. I must however get down to facts :—

Notes.—The Chikalda Plateau, with the small hot weather station of Chikalda (the headquarters of the Divisional Forest Officer, Melghat Division, who is the only permanent official resident) is about 10 square miles in extent and lies at an altitude of 3650′ overlooking the plains of Berar. *Lantana* introduced about 50 years ago (by some of the original administrators in the days when Chikalda was the hot weather resort of the old Ellichpur Garrison) as a hedge plant has, as elsewhere in India, spread unchecked and now constitutes a menace to the station. It has spread over some 600 square miles, *i.e.*, about one half the area of the Melghat Division and constitutes a major problem of forest management in these valuable teak forests. At present eradication of large bushes (1) in coupes of the year as a measure of introducing natural regeneration of valuable species and (2) along road sides and lines as a measure of fire protection, is all that a reduced budget allows the Department to do. On the Chikalda Plateau, however, the special need of protecting the civil station (1,000 acres) demands special efforts, and for many years eradication by coolies of the *Lantana* in the station has been carried out at considerable expense during the rains. Fierce hot weather fires in the *Lantana* have reduced it to some extent every year but the damage done to standing trees is such that this method of attacking it is now in disfavour. The use of elephants for the uprooting of *Lantana* has not been made before in the Central Provinces nor, to my knowledge, elsewhere. In April last the idea occurred to me while watching the

After 10 minutes' work.



The use of the Trunk.

Team Work.

divisional elephant uprooting shrubs and grass, that she might be trained to deal similarly with the *Lantana* which is such a pest at Chikalda. Accordingly she was taught with a few seers of *gur* to pull first very small and then larger bushes until after a fortnight's training (during which she was joined by the Conservator's elephant) she was able to uproot 10 years' old *Lantana* bushes of a height of 15′ without hesitation.

The training of these two elephants continued at Chikalda till the middle of May, by which time both elephants and both *mahauts* were quite proficient. The practice of handing up large *Lantana* bushes, complete with root system and adhering earth, with a graceful flick of the trunk was sternly discouraged,—bouquets of this nature being found unwelcome by the *mahauts* whose beards became somewhat ragged at the edges during the first few weeks of practice. Work was stopped in May as the hard baked state of the ground rendered eradication laborious and trying. It had however been proved that the work of pulling up large *Lantana* bushes with elephants was quite feasible. Dragging with ropes and grapnels was also tried but abandoned in favour of the foot and trunk method (*vide* illustrations). The support of the Conservator resulted in his placing at the disposal of the writer, four more divisional elephants for the period August to October for work in the rains on the Chikalda Plateau. The whole circle herd had arrived by the beginning of August and the new arrivals quickly learned by example. Uprooting in the rains was of course far more easy than it had been in the hot weather and no patches of *Lantana* were too dense or difficult for the elephants to tackle. The refinement of stacking bushes with roots in the air was also taught without difficulty. It was found that by keeping the elephants on to pulling up the large roots and using a few coolies to " roll up " the bushes on slopes, as well as to pull up small bushes by hand, the best results were obtained. Four acres of the most dense *Lantana* were finished by six elephants in four hours and this kept 40 coolies busy for the whole day (clearing, stacking and removing any remaining small bushes). Where *Lantana* occurred as scattered bushes, only the acreage completed in a day was of course many times greater. By experiment it was

found that an elephant in very dense *Lantana* working for four hours accomplished what it took 27 coolies to do. In more open *Lantana* where the bushes were not so high, *e.g.*, up to 9′ only, an elephant was found to be the equal of 15 coolies only. Where coolies are unable to swing a pickaxe at the roots of the *Lantana* the value of the elephant's work is very great. A brief description may be quoted from the diary of the Forester who was in charge of the work. This, with the illustrations, will I think be sufficient to explain the actual method.

"The elephant used to do the work in this way, that she used to catch hold of a big bush of *Lantana* with its trunk firstly, and then pulling her heavy foot over the bunch used to pull it. Secondly, in places where there was slope the elephants without using their feet, uprooted *Lantana* by twisting bushes with their trunk. Thirdly, if a branch is broken, they knelt down and used to catch the stump with their mouth and then to pull and even in this case if it is left undone, they used to kick the stump with their heavy front foot. After uprooting a branch they used to catch it with their mouth and carry it to the place where heaped or somewhere else as per order of her *mahaut*." The winding of the stems of *Lantana* round the trunk allows a tremendously strong pull to be exerted without the stems breaking and this combined with the use of the foot at the base of the stems gets the root out every time.

Work done while rain was actually falling was most efficient on level ground. On slopes in the rains an elephant can hardly spare one leg and a trunk for *Lantana* work. Steep slopes were therefore done during breaks in the rains. Even so an occasional "Telemark" turn was not unknown. The Chikalda Station area of the Plateau, 1½ square miles, has with six elephants (four hours per day) and 40 coolies working for two months been completely cleared of large bushes of *Lantana*, and a large area of the plateau outside it has also been dealt with. The remainder of the plateau as well as the Fort at Chikalda will be finished next rains.

As however every one who has had to deal with this pest knows, the most difficult problem in dealing with it is to get rid of the thousands of seedlings which appear soon after the large bushes are re-

moved. It was found that very dense shade effectively keeps the seedlings back. *Lantana* (in this province) is kept out by the shade of dense bamboo. Seeds of several shrubs, field crops, etc., were sown on the site of eradication at Chikalda and results are being watched. Up to date by far the most successful crop has been *sunn* hemp ; four seers of hemp seed gave a patch of 20 yards × 20 yards of dense hemp 3′ high in three months under which not a single *Lantana* seedling was found. The seed was thrown on the upturned earth after eradication of *Lantana* and covered over. The cost of the seed was -/6/- and the value of the standing of the hemp crop at least 2/-. Hemp has the special advantage that it does not require fencing as it is not eaten by grazing or rooting animals. The hemp experiment will be repeated on a much larger scale next year and it may be that *Lantana* work will even one day be a source of profit.

The following extract from *The Statesman* of October 18th is of interest in this connection :—

" In these dog days of trade, any straw offered to the Indian exporter is worth clutching at. But it is a rope that the Imperial Economic Committee holds out in its latest report which emphasizes the potentialities of the *sunn* hemp industry. Frequent references have been made in the past to Indian exported hemp, few of them complimentary, the criticism being directed against lack of care in preparing and marketing the fibre. As a result of slackness in these respects, *sisal* from East Africa, and *manila*, from the Philippines, have filled the British market. But the Indian producer of hemp need not despair. A vast quantity of hemp is continually required for the manufacture of marine cordage as well as ropes and twines for general use, and the Committee suggest Indian hemp will hold its own with that of the rest of the Empire if two things are done :— Information given to the peasant about the best methods of cultivation and preparation, and up to date intelligence given to the market about crops, shipments and arrivals. The report is a clear hint to those interested in the Indian hemp export industry to get together." Hemp is already extensively sown in Berar in fields which the cultivator wishes to clear of the dreaded *koorda* grass, and it was this fact that

suggested it in connection with *Lantana*. Matters are, however, still in the experimental stage and all that can be said at present is that hemp has on a small scale been so successful that its extensive use next rains is recommended. A hemp seed hopper attachment fitted to the rear of each elephant is already contemplated and the elephants will perhaps grow their own ropes ? In conclusion, I would mention that I feared that some form of illness not necessarily " foot and mouth " but something in the nature of a strain, *e.g.*, " *Lantana* elbow " might make its appearance among the elephants used on *Lantana* work but neither this nor "Housemaid's knee " has occurred so far, and the Chief Conservator of Forests' depreciation column must remain blank.

RELATION BETWEEN FIRE AND CLIMBERS IN SAL FOREST.

BY V. S. RAO, I. F. S.

My own experience goes to corroborate Mr. R. N. De's view set forth in the *Indian Forester* for November 1932, that fire has very little effect on the woody climbers in *sal* forest. I have had occasion to wonder at the abundance of stout, woody climbers (species of *Vitis*, *Spatholobus*, *Millettia* and *Acacia*) in the Chengmari block of the Apalchand Range (Jalpaiguri Division) which, in spite of its being Reserved Forest, has had fires sweeping through it at pretty frequent intervals. It was by no means an easy job that coolies had at the time of climber-cutting in this block in 1931-32.

My remembrance of the *sal* forests of Nepal on the border of North Kheri in United Provinces, which, as is well known, are subject to almost annual fires, is that they are forests of a rather open type with plenty of grass on the ground and *sal* regeneration in the grass, and no scarcity of woody climbers like *Bauhinia vahlii*, *Spatholobus roxburghii* and *Millettia auriculata* on the trees.

Experiments in the burning of *sal* plantations with a view to noting the effect of fire on climbers and undergrowth have been started in 1930-31 in Jalpaiguri Division by the Conservator (Mr. E. O. Shebbeare), the plan being to burn half the area of the plantations six

years of age and older, the other half being left unburnt for comparison. I find that after two burnings the evergreen creepers and climbers have disappeared from the burnt half of North Moraghat 1922 plantation, and the undergrowth is reduced, but I do not see any difference in the incidence of woody climbers (which are the predominant type here) like *Spatholobus roxburghii* and *Millettia pachycarpa*. It appears as though, whatever other beneficial effects fire may have, it probably is not competent to combat woody climbers. However, as the experiments are still in the initial stage, it is premature to draw definite conclusions.

A more potent factor in determining the extent of climbers in plantations seems to be the density of the canopy. Where the canopy is heavy there is a remarkable absence of climbers, even of woody ones, whereas in more open patches in this particular plantation as well as in others where woody climbers are abundant, the crowns of *sal* poles are climber-bound.

EDITORIAL NOTES

IRRIGATED PLANTATIONS IN THE PUNJAB : A MANUAL OF ALL OPERATIONS.

BY S. S. BAHADUR SINGH, E. A. C. F.

Superintendent, Government Printing, Lahore. Price Rs. 9.

We welcome the publication of this manual, for the lack of such a text book has been keenly felt for many years. Many papers and articles on this highly specialised type of forestry have appeared from

time to time, and these have registered a steady accumulation of experience since Ribbentrop first discovered the value of flooded trench berms for germinating *shisham* seed when Changa Manga was first started in 1866. The chief contributions have been :—R. N. Parker, Working Plan 1916 and *Indian Forester* 1918 ; W. A. Grieve, *Indian Forester* 1921 ; L. B. Holland,—unpublished manual 1922 ; R. M. Gorrie,—*Indian Forester* 1924, *Emp. For. Journal* 1924, and World Forest Conference 1926 Proceedings ; Allah Bakhsh, *Indian Forester* 1928 ; Bahadur Singh,—Punjab Forest Conference 1931 Proceedings, and *Indian Forester* 1932. Incidentally the manual under review contains no bibliographical list,—a serious omission when the subject has already been so widely written up by previous forest officers.

With the experience gained at Changa Manga and the evidence of the sound financial results achieved there, an attempt has been made to secure ground for at least one 10,000-acre plantation in each of the younger canal colonies. Chichawatni was started in 1913, Khanewal in 1917, both on the Lower Bari Doab, and Daphar on the Lower Jhelum in 1919, while three sites have been secured in the Sutlej Valley Project on which Arafwala, Dipalpur and Miranpur plantations are rapidly taking shape. When these are fully stocked we shall have over 80,000 acres of irrigated forest, but even this will be entirely inadequate to supply the fuel demands of the larger towns of the Punjab, and if the cultivator is ever to be supplied with wood fuel at a rate which will wean him from the wasteful burning of his cattle manure supplies a very much larger area must be afforested.

The financial case for irrigated plantations is very well stated and is based on the very conservative revised estimate which was reproduced in our December 1932 number. This shows that with careful management and constant effort to prevent waste of water, a 10,000-acre plantation can pay for itself even during the expensive formation stage. Water costs Rs. 43/- per acre on an average for the 20-year formation period and the handling of the water (including the digging of channels and trenches and the periodic clearing of silt) costs Rs. 23/- per acre, out of a gross expenditure total of Rs. 93/- per acre ; from

these figures it can be seen at a glance how *very important* the economic handling of water has become.

Sardar Bahadur Singh is an enthusiast as well as a master of irrigation technique, and the two photos which were reproduced in our May 1932 number are again published in the manual to emphasise the very striking change which can be brought about in altering useless semi-desert scrub into dense and very valuable high forest by the practice of irrigation. For many years the plantation officers' only written instructions were the typed notes written by L. B. Holland, but the delay in publishing has been a real gain in the end, because Bahadur Singh has since done much to standardise irrigation practice, and his most notable contributions, apart from field experiments in the most economical use of water, have undoubtedly been in the more scientific measurement and control of available water supplies.

The new manual contains detailed instructions for the lay-out of an irrigation system basing the size of the distribution channels or *khals* on calculations from Kennedy's formula for the rate of flow of water under given conditions. The digging of borrow-pits which have caused much waste of water in the past is now prohibited and soil is dug only from pits in the bottom of the main channel which *will automatically silt up in the course of a season's irrigation.* Long lengths of trench are now avoided by having cross-roads 10 feet wide with a *pasel* or link trench on either side running midway between every two *khals ;* this is a considerable improvement on the earlier methods in which single lengths of unbroken trench were much too long.

Soil analysis shows that the wide variations in tree growth cannot be correlated with any radical change and we are forced to realise that *these changes are due to physical factors based upon the distance down* of the underlying pure sand and less frequently upon the occurrence of *kankar* pan which interferes with drainage. The depth of the underlying permanent water table is also a most important factor and careful measurements are being kept of the gradual rising of this table in the new plantations. This is only a part of the larger problem of wholesale waterlogging which confronts all the Punjab perennial irrigation canals, though fortunately a general raising of the water

table is more likely to help than to hinder our existing forest plantations. The figures for Daphar show a rise from 40 feet in 1919 to 15 feet in 1930—2 feet a year—which indicates the magnitude of this problem to the canal colonies as a whole.

There are many areas which are now so heavily waterlogged as to be unfit for agricultural crops and which have been deserted by the previous cultivators who have had to be accommodated at Government expense in new canal colonies. Such areas may yet be reclaimed by planting some forest crop of shallow rooted species grown on ridges, and although this is outside the ordinary technique of the irrigated plantations, the possibility of further expansion along this line should not be lost sight of.

The author notes that serious damage was done in Changa Manga by drought in 1921, but in actual fact the killing of large areas of both *shisham* and mulberry was due to the old plantation being deprived of its legitimate supply of water from 1919 onwards when the ill-advised Shahpurjand extension was persisted in, in face or the previously expressed opposition of several experienced forest officers. The old plantation suffered particularly in this way in the famine years of 1920 and 1921 and a census taken in 1924 showed that there were some 30 lakhs cubic feet of dead standing wood rotting in the forest. The subsequent fungus scare of 1925 when B. O. Coventry reported that the whole plantation was rapidly dying out from a root fungus attack, was really a carry-over from the damage of previous drought years. It is unfortunate that such a telling example of the effects of water shortage has not been put on record in the manual.

Amongst the other species discussed as alternatives to *shisham* and mulberry, Bahadur Singh is, I think, unduly pessimistic as to the future of *Melia azedarach* (*bakain*). There is a great potential market for this timber in the cheap furniture trade, as it is not unlike *tun* (*Cedrela toona*) in appearance and works up well. As a plantation tree it withstands sudden drought better than either *shisham* or mulberry and is thus a most useful species to have in the mixture as an insurance against failure of canal supplies.

The need for finding good alternative species was first emphasised by R. N. Parker in 1916, and although in Changa Manga the mulberry has done exceedingly well and the planting of *Eucalyptus rostrata* is also now being done on a commercial scale, we have no sound reasons for assuming that both will do as well in the younger plantations of the Sutlej Valley Project. The latter areas are definitely nearer to desert conditions than any of the older plantations, and to my mind the success of mulberry as the major crop should not be assumed as a certainty. It is not by any means a good drought resister, and from experience up to date in the difficulty and uncertainty of the Sutlej water supplies in April and May, it seems likely that these new plantations are going to have some very difficult years ahead when the competition from agriculturists for the available water becomes keener. The soundest policy would therefore appear to be to accept the present system of regeneration work for *shisham* as standard practice and to introduce mulberry whenever possible, but to continue to experiment with any likely alternative species and to try to develop a planting and irrigation technique to suit their requirements.

Although these Punjab plantations are a specialised form of forestry, there is much in the technique which should be of interest to forest officers who are attempting any form of irrigation in plantation work elsewhere. We can therefore thoroughly recommend the present volume to their notice.

R. M. G.

MEN OF THE TREES.

BY R. ST. BARBE BAKER.

This book is a refreshing collection of essays and pen pictures from African forests, but the foreword written by an eminent anthropologist emphasises its value in so far as it adds appreciably to our knowledge of some of the backward forest tribes of East and West Africa. This is a problem which confronts us in many parts of India as well. Educational and political development is making rapid strides in urban areas and in the better organised agricultural parts, and if rightly guided, should be of immense value to all their residents,

but amongst the aboriginal tribes of our North-East Frontier and other backward tracts there is much to be said for the patriarchal guidance of the " one man show" as demonstrated by our permanent Political Officers. In such an administration the primitive customs of the people must be respected and any improvement in their well-being can only be brought about by developing and improving their cherished customs, which otherwise tend to be at cross purposes with the trend of modern progress. In forest districts this is particularly so, for the primitive and destructive methods of shifting cultivation cut right across scientific forest management, and the two points of view can only be reconciled by a combination of both.

In many parts of India and Burma the destructive tendency of shifting cultivation has been skilfully guided into the helpful channels of organised *taungya* plantation work, and the firm loyalty shown by some of the aboriginal tribes to their local forest officer shows how essentially sound that guidance has been. We must prevent our work getting too stereotyped, however, and in the book under review we have a reminder that other lines of attack can be successful. Captain Baker has utilised the Boy Scout principle of service to others combined with amusement for oneself, and has persuaded the tribesmen to take up tree planting as a hobby by developing a ceremonial tree planting dance on the lines of their ancient customs and inherited love of dancing. The account of how this organisation started and its chequered career in face of official discouragement makes most interesting reading.

There is much that is similar in the forest history of Africa and India. The early disforestation of the plains and foothills of our North-West has been followed by the inevitable dessication of the climate and the eventual depopulation of the country-side, when wells fail and fertile fields are eroded away. The same process is now going on apace in many parts of West Africa, where the enveloping sands of the Sahara are completing the destruction of the forest so efficiently started by Arab goats and nomadic farmers.

R. M. G.

"THE TRANSPORTATION OF WOOD IN CHUTES"—

YALE FORESTRY BULLETIN, NO. 34.
A. M. KOROLEFF & R. C. BRYANT. PRICE ONE
DOLLAR FROM YALE SCHOOL OF FORESTRY,
New Haven, Connecticut.

This is a very welcome addition to the literature of forest engineering, for as the foreword points out there is no comprehensive English treatise on the subject and we can recommend it to any forest officer who is interested in the technicalities of exploitation work or who is contronted with timber transport problems.

The book is divided into two sections, the first giving the details of constructior of various types of chute, and the second the theoretical considerations in chute construction. The types most fully described are the popular American patterns of (1) V or U-shaped channels of poles or hewn logs which are discussed in considerable detail along with the various braking and switching devices: (*ii*) trailing chutes and earth chutes for dragging by horse or engine power, (*iii*) wet flumes of planks built up in a V to carry water-borne material, (*iv*) various commercial patent types of portable wooden and metal troughs (*v*) a tubular chute of metal sheets suspended from an overhead cable, which sounds a rather unpractical toy, (*vi*) a rail chute of 4 steel rails mounted on shaped cross ties to form a channel—an expensive type but one which might be useful for short lengths in sawmills and depots, (*vii*) a roller chute which might be useful on flat grades where reduction of friction becomes important, and (*viii*) the Deota timber slide as used in Chakrata 55 years ago and described in C. G. Rogers' ***Manual of Forest Engineering.*** This was constructed of three 5-inch planks wedged into cross-ties six feet apart, but has long since been replaced by the modern standard Himalayan wet slide made from three broad-gauge sleepers, the advantage of the latter being that when the slide is dismantled, practically all the timber used in its construction can be exported. This particular type is not mentioned anywhere in the book under review.

An interesting item is the discussion on the Japanese Miura's experiments on the elastic suspension of the brake pole by inserting

its uphill end in a twisted cable slung between two upright posts, for so far as we are aware this work has been written up entirely in German and has not hitherto been described in English. Miura's work has shown that elastic suspension of the brake pole is much more effective and gives longer service than the older type of rigid attachment by chains to an overhead crossbar.

Although the use of chutes has given way in European practice to the wider use of road transport, this is apparently not the case in America, and in our Indian practice, there must always be opportunities for using wet or dry slides in preference to any other means of timber transport.

R. M. G.

PROVISIONAL VOLUME TABLES AND DIAMETER GROWTH CURVE FOR *SEMAL* (*BOMBAX MALABARICUM* DC.) IN THE CENTRAL PROVINCES.

BY ISHWAR DAS MAHENDRU (INDIAN FOREST RECORD, XV, PART V).

At the request of the Central Provinces Forest Department a field party was sent from the Forest Research Institute in November 1931 to collect data for the compilation of volume tables and a growth curve for the local *semal,* as it was realised that the published figures based on trees measured in the United Provinces were not directly applicable. It was only possible to work in Chanda District and the party toured with the Provincial Silviculturist for six weeks in North and South Chanda Forest Divisions, obtaining data from three different localities.

The three localities cover a decided range of environmental conditions. At Kanhargaon in South Chanda, the *semal* occurs in moist mixed deciduous forest (without teak) in which *Pterocarpus marsupium* (*bija*) is the characteristic species. In the Jainara forests in North Chanda on the other hand, it is found in the dry mixed deciduous type (with teak) under decidedly less favourable conditions, the trees being definitely slower in growth, and lower in height and poorer in form. Moharli, also in North Chanda, presents a transition between these two types.

STUMP TRANSPLANTING OF TEAK IN TRAVANCORE.

Referring to your query on page 646 of the *Indian Forester* for November 1932 on the subject of stump transplanting, I write to inform you that stump planting of teak is no new method so far as Travancore is concerned. The State has an area of over 11,000 acres under teak plantation, the oldest of which is about 56 years in age now. Every year on an average one square mile of new plantation is added and the trees in all these plantations are raised by stump transplanting. Plantation work on a systematic and extensive scale was started about 40 years ago and since then every tree in our plantation has been raised from stump planting. The method followed by us is to sow the teak seeds in beds 10′ × 3′ in nurseries in the month of July and the plants remain in the nursery in rather a congested state for nearly a year when they are dug out of the nursery and the stem is cut off with a sharp knife from the root leaving only an inch or less of the stem. The tap root if it is too long is also cut off and the rootlets trimmed. This stump which will be about 1′ in length is transplanted into holes made with crowbars at distances of 6′ × 6′ and the soil pressed round it. Experience has shown that stumps about the size of a blue pencil give better and stronger shoots than thicker stumps and hence the plants in the nursery are grown congested and not allowed to grow freely. The transplanting is done in the month of July with the outbreak of the monsoon here and when the stumps are one year old. In transplanting only half an inch of the stump is allowed to project out of the hole, so that the stumps planted can hardly be seen again on the ground unless the exact spot is indicated by marks ; this is usually done by pegging a stake of *eeta* reed. Vigorous shoots begin to appear in a fortnight's time from the collar of the stump and attain a height of about 10—20 feet in a year. Plants from stumps come up vigorously and attain greater height than by any other method, not to speak of the cheapness of the cost. Stump planting was started in Travancore over 40 years ago and it is the method followed so far.

R. DHANUKOTI PILLAI, AVL., B.A. (OXON.),

CONSERVATOR OF FORESTS, TRAVANCORE.

EXTRACTS.

THE ASIATIC SOCIETY OF BENGAL.

Although scientific workers in many fields are familiar with the publications of the Asiatic Society of Bengal, few, probably, are aware of the mass influence of this ancient foundation upon Indian progress. A glimpse of the long history of the Society was given by Dr. Rai Upendra Nath Brahmachari, in his presidential address in 1929, just published in the *Journal and Proceedings* (N. S., Vol. 25, 1932). Founded in 1784, as the result of an appeal by Sir William Jones for the institution of a society to inquire into the history, civil and natural, the antiquities, arts, sciences and literature of Asia, and numbering amongst its early patrons, Warren Hastings and Lord Cornwallis, the Asiatic Society set going inquiries of a kind which had fallen into abeyance in the India of the late eighteenth century. Its " Asiatic Researches " created so great an impression in the literary world that in 1798 a pirated edition was brought out in England, and on the Continent a French edition, " Recherches Asiatiques, " appeared in Paris. So early as 1808, a year after the formation of the Geological Society of London and only eighteen years after Werner had propounded at Freiburg his doctrine of " Formations," a special committee was formed " to propose such plans and carry on such correspondence as might seem best suited to promote the Natural History, Philosophy, Medicine, improvements of the Arts and Sciences and whatever is comprehended in the general term Physics."

At first geology and mineralogy received most attention, and the names of many distinguished workers figure amongst the early contributors—Voysey, the father of Indian geology, Oldham who created the Geological Survey of India, Lambton of the Indian Survey, Schwendler one of the chief founders of the Calcutta Zoological Gardens, Falconer, Cautley, Colvin, Baker, Durand, to mention a few. Indeed there are few activities in the scientific life of India which have not been linked with the Asiatic Society, from the early ethnological survey of Col. Dalton, and the grand series of papers on the fossil mammalian fauna of the Sub-Himalayas, to the foundation of the Indian Museum and its offshoot the Zoological Survey. The president added a note of warning about the risk of starting new scientific

periodicals, the competition of which might result in the double misfortune of loss both to the new and the old, and made a plea for consideration of the possibility of concentrating upon the oldest journal of all, the *Journal of the Asiatic Society of Bengal*, with which, he considers, many of the new journals might be amalgamated profitably.—*Nature*, 22-10-32.

THE WORLD'S SPRUCE SUPPLIES.

Following is a copy of a letter written by Mr. Frank J. D. Barnjum, of Montreal, *Canada, to Canadian newspapers on August 7th, 1930. Mr. Barnjum has for years* been a student of the question of the world's timber supplies, and was one of the two Canadian Forestry Representatives on the Forestry Committee of the 1930 Imperial Conference held in London.

" Having just returned from a second visit to Germany this season where I had the great privilege of the company of the eminent forester, Dr. C. A. Schenck, during my forest investigations and studies of world forest conditions, I cannot do better than give the Canadian people the benefit of the result of these studies, in the following especially prepared statement in Dr. Schenck's own words. *(Dr. Schenck is reputed as one of the most outstanding living authorities on forestry, author of numerous books on silviculture, and international forestry adviser.)*

" ' The reader may ask, " What is forestry ? " An old problem for the philanthropist and economist, and a problem, which, in spite of its age, is nowhere fully solved.

" ' In the last analysis forestry must be common sense applied to woodlands ; common sense applied by the owners ; common sense applied by the people.

" ' Unfortunately, what is common sense for the owner is frequently antagonistic to the demands of the people. The owner desires to make money out of the woods regardless of the consequences resulting for the people. The people desire to use the woods for their benefit regardless of the owner's vested rights.

" ' There is no productive forest policy, practically speaking, in Canada, and if there is no such forestry being practised in Canada, so far, in spite of the prevalence of common sense, what are the reasons ? And why is it that Germany, France and Sweden are strongly entrenched in forestry, while England is just beginning to practice it ?

" ' Let us go back to France and Germany in the year 1650. At that time their primeval woods had been utterly despoiled, and a fuel famine was imminent in all their centres of population. Coal was unknown, and, had it been known, it could not have been utilised for lack of rail or river transportation. Fuel-wood was needed, and, without fuel-wood, the centres of population were in fear of death from cold and hunger. At that time, forestry was born, not by monarchic foresight, but born by actual fear of death. When that fear had subsided 180 years later, systematic forestry was so strongly established in Germany and France that the people would not now consent to any change,

" ' In England and in Holland the case was different. By the help of their merchant marine they were able to obtain what wood was needed from the Baltic regions. There was never any fear of a fuel famine in England and Holland, and for that reason there was never any forestry. To-day, if Russia were to cease exporting raw wood, the paper mills in Germany would be badly affected, and those in England, France and Holland would be ruined.

" ' The German stands are so little that the entire Black Forest, for instance, does not produce spruce enough to supply one single concern, *viz*, the Zellstoffabrik Waldhof, situated at the foot of the Black Forest, and **all the wood now standing in Germany would only last the United States, if used for all purposes, about eighteen months,**

" ' The case of Sweden is interesting. Sweden was described by English travellers in 1830 as utterly devastated. By that time the bulk of its primeval woods had been despoiled. In the meantime, by 1930, a second growth has, through a wise forest policy, established itself; and this second growth has a commercial value for the reason that there is no coal in Sweden whatsoever, so that its railroads, its factories and its households cannot be run without fuel-wood. The lack of coal is, from the forester's point of view, for Sweden a blessing in disguise.

" ' Nevertheless, traversing the Southern one-third of Sweden where the woodlands are privately owned, one will look in vain for trees of a size sufficient to make a telephone pole. In that section Swedish forestry is not timber forestry, all efforts of the people to the contrary notwithstanding. It is brush forestry privately practised.

" ' There is one very important industry, in fact, Canada's most important manufacturing industry, which actually faces death when the woods are despoiled, and that is the paper industry. The best tree for the manufacture of paper is the spruce tree of which there are in Canada six species. Canada has been and is to-day the real home of the spruce. No country on earth could boast of a larger area stocked with spruce than could Canada. Alas! Canada is losing its lead and will lose it for ever if the devastation and reckless exploitation now going on is permitted to continue unchecked.

" ' There is sure to be a world famine in spruce wood. There is no substitute comparable with this rapidly disappearing wood for the manufacture of paper, and rayon silk, as no other raw material is so uniform or so cheaply handled as spruce; and none is so close to good water and to water power, both essential to paper making.

" ' The world is short of spruce. The best paper mills in England, Germany, France and Holland obtain their supply to-day from Finland and from European Russia. Finland, however, is a small patch on the map, and what spruce there is in European Russia, is inaccessible unless it be situated in close proximity to floatable streams such as the Dvina and the Pechora. The area capable of producing spruce in that section is about as large as the province of Ontario (360,000 square miles). It is badly exhausted, and were it not exhausted, it is unable to supply the needs of Europe.

" ' Siberia has been described by some travellers as a real ocean of spruce (*Picea obovata Ledeb*). The Soviet republics have started, however, specific investigations

with the result that spruce in *Siberia*, while it happens to occur scatteringly and sparingly, cannot be exploited for technical reasons. The rivers draining Siberia are frozen when the harbours at their mouth are free of ice, and the harbours are covered with ice when driving on the rivers is possible.

" ' In the extreme East, in Japan, there are five kinds of spruce, but all are rare; and Japan's northernmost island, Hokkaido, while containing more spruce than the rest, does not supply enough material for the Japanese market. As a consequence, the Japs are compelled to obtain what additional spruce they need from the so-called maritime provinces of the Soviet republic. The species native to these provinces is known as *Picea jezoenis Carr and Maxim.*

" 'In the Western sections of China, in inaccessible altitudes, there are some species of spruce. They are, however, isolated and inaccessible for all intents and purposes. The same remark applies to Schrenk's spruce (*Picea schrenkiana Fisch and Mey*), the typical tree of the high ranges of Tibet and the Altai mountains. In the Himalayas there is Webb's spruce (*Picea spinulosa Henry*) and Smith's spruce (*Picea smithiana Boiss*) at very high elevations, scarcely accessible, and yet the only spruce on which the future supply of India depends.

" It might well be asserted that the spruce wood of Asia, as far as the world's supply is concerned, might just as well be situated on the moon. It is impossible, whatever the developments of transportation might be, to bring these spruce supplies to the markets of America and of Europe.

" ' As for the United States, spruce is practically gone, and, without the help of Canada, the newspapers of the United States are lost.

" ' Canada is, in the face of these facts, in an unusual position. She has in the spruce game all the trumps in her hand.

" ' Alas! She is playing a poor game. She is wasting her trump cards; and she must lose the game in the end—unless the newly elected incoming Government takes immediate steps to conserve her small remaining supply through every means in its power.'

" The above brief but carefully considered and startling summary of the world's spruce wood supply, prepared by Dr. Schenck, an authority who is conceded to be the world's best informed living forester, should arrest the attention of every thinking Canadian, and result in the formation of a national forest conservation policy for Canada before all is lost."

(*Leaflet published by N. Z. Perpetual Forests, Ltd.*)

PRESENT POSITION OF THE PROBLEM OF SPIKE DISEASE.

BY M. SREENIVASAYA.

Abstract from Current Science, November, 1932, of a lecture delivered at Coimbatore, under the auspices of the Society of Biological Chemists, India, on 8th October 1932.

Two schools of thought have influenced the study of Spike Disease both in the field and in the laboratory, since its discovery by McCarthy in the year 1899,

Exponents of the physiological school believed that the characteristic symptoms induced in sandal are due to the imposition of an unfavourable environment, brought about by drought, fire, deprival or death of host plants, unbalanced sap circulation, unfavourable host plants and other purely physiological causes. In 1917, Dr. Coleman lent brilliant experimental support to the " infectious theory " of spike disease by the experimental disease transmissions he was able to effect by cleft grafting, the scion for the operation being derived from a diseased plant. This achievement marks a definite stage in the history of spike investigation.

Cleft grafting is a difficult technique ; the percentage of success is small, even in the hands of the expert ; the operation involved the cutting back of the stock and this gave the plant " a severe physiological shock," in the words of the exponents of the physiological theory, who tried to explain away the most important and definite result achieved by Dr. Coleman.

It is true that his experiments were conducted on stocks growing under natural conditions ; it is also true that the host plants nourishing the operated stocks were not determined. Other methods of transmission by budding and sap injection had failed. It was at this stage, that the problem was taken up by the Indian Institute of Science in the year 1927, the Government of Madras and the Commission of Coorg having generously agreed to finance the scheme proposed by Dr. Norris.

Culture of sandal plants in pots in association with known species of hosts marked the next important stage in the progress of Spike Disease investigation. This achievement, simple as it appears at the moment, helped to remove the reproach inherent to experiments conducted under uncontrolled, natural conditions where many unknown and non-determinable factors operate. All experiments conducted at the Institute have been done with pot cultured sandal plants, whose nourishing host, age and physiological condition are all definitely known.

The development and perfection of an easy and an effectively reproducible artificial disease transmission is an important step indispensable to the progress of the investigation ; new methods of disease transmission, extremely simple and elegant involving no " physiological shock " to the operated stock have now been evolved ; the weight of the infective material has been reduced to a few milligrams of diseased tissue. This method which has lent itself to quantitative control, has been of immense value in evaluating the relative resistance or comparative susceptibility of individual sandal plants growing under different conditions of enviornment ; the technique has also been employed in determining the resistance offered by a composite environment to artificial infection.

The simplest and the readiest way of diagnosing spike is through the external symptoms ; but the method often fails even in the case of the experienced observer. This is how the exponents of the physiological theory have been misled and have mistaken these symptoms generally produced through drought, fire, etc., as those of genuine spike. Symptoms produced through physiological causes are not communi-

cable to other healthy plants through grafting while those of genuine spike are readily transmissible. Communicability of the symptom from one plant to another is the criterion on which the infectious nature of spike disease has been firmly established.

Relative immunity can be imparted to the sandal plants by nourishing them with certain types of host plants, generally non-leguminous. *Pongamia glabra, Cajanus indicus* and *Acacias*, generally those which favour a rapid growth of the parasite, render it particularly susceptible to disease. The observation is borne out not only by ecological survey of the diseased and healthy areas, but also in the regeneration plots where only those associated with leguminous hosts have succumbed to the disease.

Mr. Dover of the Forest Research Institute, Dehra Dun, supplemented the lecture with an account of the entomological work which is at present mainly directed to prove whether insects are vectors or not.

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THE BETTER UTILISATION OF FORESTS FOR GRAZING.

For the Conference of the Animal Husbandry Wing of the Indian Council for Agricultural Research held in Delhi in February, it was originally intimated that the title of this article would form an item of the agenda, and steps were taken to have the Forest Department represented at the discussion, but unfortunately it was subsequently omitted and an excellent opportunity has thus been lost for demonstrating to those interested what is being done by the Forest Department in various parts of India to help the *zamindars* and villagers in their grazing problems. The following notes have been collected with the object of summarising the present position :—

Statistics of Forest Grazing.—Out of the total land in the charge of the Indian Forest Department (225,000 sq. miles) over half (124,000 sq. miles) lies in Burma, where the grazing question is of minor importance owing to the sparseness of the population. We are chiefly concerned with the remaining 100,000 sq. miles in India proper. Out of this total forest area, practically 80,000 sq. miles are open to grazing but the incidence of grazing varies enormously. The higher Himalayan forests are practically unused, and the great belt of forest along the foot of the Himalayas in Bengal and United Provinces is out of reach of the cultivators; in fact, out of 41 million head of cattle in U. P. only one million, or 2½ per cent., make any use of forest grazing areas. In the Punjab the foothills belt is much more densely populated and thus the forests are much more heavily grazed. In the Central Provinces, Bombay and Madras, also, the agricultural population makes greater use of the forests, which are here interspersed among cultivation. Even so, grazing is generally confined to the outer fringes of each forest block, so that figures of general incidence

do not give any true indication of the tremendously heavy incidence which occurs in many localities. The value of grass and grazing obtained from forests free or at concession rates varies from over Rs. 20 lakhs in the Punjab for less than 7,000 sq. miles of forest, to less than Rs. 20,000 in Assam for 20,000 sq. miles.

Extent of Problem.—It must be remembered that the forest grazing problem is only one part of the much larger problem of Indian animal husbandry as a whole, and that the obvious remedies indicated by the Royal Commission on Agriculture for the general improvement of farm animals and the means of feeding them, apply equally to communities dwelling in or near forest tracts. There are, however, additional considerations applying to the interaction of grazing and forest management which make it all the more essential that the vast numbers of excess cattle maintained by most village communities living near forests should not become a drain upon forest resources.

Most of the early forest settlements were so liberally framed that no check can be exercised under them upon the number of animals which can graze in a given forest area, and with the phenomenal growth of population and of live-stock under the protective influence of British rule, what was originally a reasonable privilege to graze a few head of cattle has now grown into an intolerable burden of over-grazing, which not only ruins any chance of improving the forest silviculturally, but in many cases is leading to active erosion and the eventual disappearance of any vestige of woodland or even of grassland.

Classification of Grasslands according to Rainfall.—The Agricultural Department has proved by practical demonstrations that while continuous, unlimited, and uncontrolled grazing creates definite deterioration, grazing in itself, when properly regulated, is not necessarily an evil even in intensively managed timber forests. Even intensive grazing, provided it is properly controlled and not continuous, will allow the vegetation to follow out its natural progress towards an ecologically higher type of plant community. But the actual amount of grazing which will not interfere with such progress

depends largely upon the amount and distribution of the rainfall. We can thus classify all forest grazing grounds into one of two classes which are separated roughly by the 50 inches of rainfall mark.

In the heavy rainfall class with anything over 50 inches, the natural vegetative cover which tends to develop is some form of dense tree forest, in which grassland is sooner or later ousted by tree growth, and if grasses occur, they tend to be large perennials of coarse and fibrous texture. In such conditions any attempt to improve the grazing quality of open forest or scrub. land must involve interfering with the natural tendencies of nature by delaying the advance of denser jungle. Timber production and grazing improvement are therefore incompatible in such areas.

In the areas of light or deficient rainfall, however, things are quite different. Here grasses rather than trees form the major part of all natural crops in all stages of development, and even the ideal or climax forest generally contains a large amount of grass. Moreover, the highest species of grass in an ecological sense are also the most valuable for feeding purposes, because leafy annual grasses are not, as a rule, ousted by the coarser perennial fibrous ones on such sites. In the dry zone the best fodder is, as a rule, found on the damper sites. Maltreatment by continuous overgrazing will inevitably throw such areas back to a less valuable fodder type as well as causing deterioration of the forest, while better utilisation of the fodder is synonymous with better forest management. It is in such areas of light or deficient rainfall that Dr. Burns' illuminating experiments on grazing in Bombay have been made, and it is obvious that it is in such areas that the Forest and Agricultural Departments can best co-operate in demonstrating better utilisation of forest grazing.

Findings of the Royal Commission on Agriculture in India.—The recommendations having a direct bearing upon the forest grazing problem were as follows (page 276 of Commission's Report):—

1. Grass cutting should be encouraged as an alternative to grazing.
2. The grazing of inferior cattle in the forests should be discouraged.

3. The intensity of grazing consistent with the proper development of the forest and the preservation of desirable grasses should be determined as soon as possible.

4. Forest areas in each Province should be classified with a view to determining which are most suitable for the growth of timber, for preservation under forest on physical grounds, or for development as fodder reserves and grazing grounds.

Of these, Nos. 1 and 2 are largely dependent upon the wider question of the improvement of stock as a whole. The Forest Department cannot progress far in substituting grass cutting for grazing unless and until the villagers have cattle for which it is worth cutting grass. Even partial stall-feeding is only worth while for picked animals and is out of the question for large herds of semi-starved animals. Similarly the grazing of inferior cattle in forests cannot be discouraged actively until the larger problem of reducing the numbers of surplus cattle has been taken in hand.

Nos. 3 and 4 also seem to be rather superfluous until more practical steps have actually been taken to reduce the incidence of grazing where it is obviously excessive. There is little point either in knowing the proper intensity of grazing for any given site, or in segregating land for timber production, when the whole of a forest is in actual fact deteriorating rapidly through overgrazing.

SUMMARY OF POSITION IN DIFFERENT PROVINCES.

Assam.—No large scale fodder operations have been undertaken, and taken as a whole, the grazing problem is not acute. Substitution of grass cutting for grazing is not possible, but the influx of graziers from outside the Province has rendered necessary the reservation of grazing grounds for local needs. Where there is local demand for fodder, arrangements have been made to set aside portions of Unclassed and Reserved Forests for grass cutting.

Bengal.—In Northern Bengal the combination of grazing with profitable forestry is impracticable owing to the denseness of the

forest growth. A great advance in encouraging stall-feeding has been made by building *bathans* (cattle sheds) at Government expense and charging only a nominal rate for cut fodder. This was very unpopular at first but the graziers are now beginning to see that their cattle are improving, and are in places applying to be allowed to build their own *bathans*.

In Southern Bengal there is of course no grazing whatever in the Sundarbans. In the remaining forest divisions, available grazing grounds have been invaded by *Eupatorium*, whose shrub growth kills out the grass. Proposals for the transfer of certain *khas mahal* forests to the Forest Department are under consideration, but it would be preferable to run them as grazing grounds rather than attempt to exploit the scanty forest growth they contain. Villagers would have to undertake the cutting back of *Eupatorium* and the planting of "African grass" roots, which have been favourably reported on by the Agricultural Department. In the Chittagong Hill Tracts all cultivation is shifting, and here again all abandoned cultivation is invaded by *Eupatorium*.

Bihar and Orissa.—Government forests here are only 3 per cent. of the Province and are true forests with no natural grassland. Where grazing is allowed it is governed by rotational closures under the working plans.

Bombay.—Much work has been done by the Agricultural Department here in grass improvement, particularly in the dry tracts, proving clearly the need for fencing, limitation of head of cattle, prevention of grazing during early monsoon, provision of watering facilities, and tree planting for shade. The Forest Department as tenant of a large portion of the true grazing land has co-operated in this work and has already arranged for proper grazing rotations and facilities in several of their Working Plans, notably that for Junner. Special areas for grass cutting are reserved for local users where this is necessary. The Grazing Rules provide for the limitation of head of cattle by the Collector, but this has never been made use of, and excessive grazing is almost universal, to the detriment of both the stock and the grazing

grounds. The problem is particularly serious in Bombay Presidency's dry tracts.

Burma.—As explained in the introductory notes, the question of grazing improvement is a minor matter in Burma, and this province may be omitted altogether from the discussion.

Central Provinces.—Although there are large areas in the 19,000 square miles of Government forest which are not grazed at all, an immensely heavy incidence occurs in all fringes of forest adjoining cultivated areas. The cultivators in such places take no steps to reduce the size of their herds, which are only thinned out periodically by famine years. The cultivators who live beyond reach of any forest, on the other hand, keep only such cattle as they can keep properly fed. Unfortunately the chance of improving the local breed in non-forest areas is spoilt by the fact that all replacements are made from purchases of the cheap and underbred animals from the forest fringe herds.

The regulation of forest grazing is done under all working plans because approximately 80 per cent. of Government Forests and nearly all private ones are classed as pasture land in which, according to the Royal Commission on Agriculture, the preservation and improvement of pasture should be the primary object of management. Revisions of plans are scrutinised by a specially appointed revenue officer who tours the tract in the company of the forest working plans officer and discusses the draft prescriptions which are to affect the grazing with him. The officially accepted incidence is 3 acres per head, but this is often reduced, as the revenue officer frequently finds that there is not enough grazing for the existing cattle and therefore prescribes a higher incidence. If the working plan officer protests he is told that the forest is not classed as a tree forest. It is generally recognised that the incidence should be very much lighter on light sandy soils, but no figures are available in support of this. Many of the best fodder grasses are annual, and if heavily grazed, they are ousted by the coarser perennial grasses or shrubs such as *Cassia tora*, and heavily grazed areas can only be saved from deterioration by periodic closure, and by a drastic reduction in the useless herds of forest fringe grazers

Experiments are in progress in several forest divisions to determine the best method and season in which to harvest the grass crop from various types of forest land, comparing fertile valleys with the higher waterless tracts, and also to determine the permissible grazing incidence for such types. From results to date it appears that very lengthy closures do not bring about any cumulative improvement in the grass crop after the third year of closure. Local experience also tends to show that at any rate on trap soil some grazing is indispensable in securing the natural regeneration of teak.

It can thus be seen that the whole silvicultural prospects of the Province are bound up in the successful reconciliation of the conflicting claims of pasture preservation and the production of the vast quantities of poles and fuel wood which are equally essential for the welfare of the C. P. agriculturists.

Madras.—The forest grazing problem in this Presidency is complicated by the fact that the heaviest incidence falls upon the *panchayat* forests which adjoin the villages more closely than the reserves do. The Forest Department has no data whatever for the *panchayat* forests, and absolutely no control over them as they are entirely separate from the forest administration. All we know is that there is almost universal deterioration owing to excessively heavy and unregulated grazing. This also applies to reserves, but to a lesser extent because in most working plans some attempt has been made to provide for closure at least for forest regeneration work. 12½ per cent. of forests under the Forest Department have some form of closure applied to them. The grazing incidence in reserves is nominally 5·5 acres per head, but in populous districts (*e.g.*, Lower Godaveri) it falls to 2 acres for the district, which represents an enormously heavy incidence in the fringe of forest adjoining cultivation. The Chief Conservator of Forests recommended in 1920 that a reduction of grazing should be effected by the enhancement of grazing fees and that grazing in reserves should be controlled by forest blocks instead of by ranges—*i.e.*, reducing the size of the control unit. This, however, was not accepted by the Government, and the result is that the damage and deterioration from over-grazing in the drier parts of the Presidency are becoming rapidly worse.

Punjab.—It has been fully realised for many years past by all forest officers in the Punjab that very rapid and widespread deterioration was taking place in almost all the foothill forests through overgrazing. Several papers and publications have emphasised this. The historic examples of the Hoshiarpur *chos*, and the denudation and erosion which are rapidly ruining the grazing value of the foothill grazing grounds, are undeniable facts which are only slowly penetrating to the notice of a wider public. Unfortunately very little can be done until public opinion has come in on the side of regulation and restriction of grazing, and legislators dependent upon popular vote will not risk a loss of popularity by taking up restrictive measures. We as forest officials know fully well what is required, but there is no possibility of carrying out what is necessary unless and until the grazing communities of the foothills can be persuaded to try restriction of grazing in their own interests. Meanwhile widespread deterioration goes on apace and gets obviously worse each year that proper management of the grazing grounds is delayed.

United Provinces.—Out of 41 million head of cattle in the Province, only one million makes any use of forest grazing. In the U. P. forests, grazing forms only a small part of the larger problem, for there is far more need for grazing regulation in the 25,000 square miles of other waste lands than in the 5,000 square miles of reserved forest. The amount of denudation and erosion going on at present in many of the plains districts such as Etawah is appalling, and is very largely due to over-grazing on land which is peculiarly vulnerable to damage once the original mat of herb covering has been destroyed.

It has been definitely proved that a supply of good fodder grasses can be much improved in *usar* and ravine lands by simple closure to grazing and substituting grass cutting, or restricting the grazing to definite periods. Improvement of grazing in the reserved forests has been prescribed in several of the current working plans, *e.g.*, cutting back thorny plants usurping grasslands and introducing better fodder grasses.

EUROPEAN SILVICULTURAL RESEARCH : PART V, SILVICULTURAL SYSTEMS AND NATURAL REGENERATION.

By H. G. Champion, I.F.S.

It has been noted in the preceding articles that the reaction against the pure spruce forests which were all the rage in Central Europe in the latter half of the nineteenth century, cannot fairly be altogether ascribed either to the clear felling system or to pure crops as such; the specific peculiarities of spruce and faults in management details have undoubtedly also played a large part. Acceptable analyses of the relative contributions of these factors are however lacking and only personal opinions are available.

The reaction was bound to be in favour of natural regeneration and mixed crops, and the difficulties encountered in so many forests have led to developments in two different directions. One line has been the lengthening of the regeneration period and a corresponding widening of the interpretation of the term 'even-aged' till it virtually merges in practice with age-distribution conditions prevailing under the selection system. The other line has been towards special arrangement of fellings under the regular systems aiming at rendering regeneration more certain and quicker, early artificial supplementing being usually considered admissible or desirable if natural regeneration is slow to appear.

The natural extreme development in the first mentioned direction, is a reversion to the selection system or a repopularisation where it was tending to be displaced. This has happened in many areas especially with mixed coniferous forest which lends itself better perhaps than most types to the selection system as practised under European conditions. Swiss forest officers, including the head of their Forest Research Institute, appear to be particularly inclined this way. It may be said that the intensive forms of the selection system are slowly gaining ground, but once again more as a result of an almost unrealised swing of the pendulum, than as a result of intensive research into relative merits. In specific instances, of course, masses

of data have been displayed as proving the superiority of this or that method, but the comparability of the data for the *pro* and the *con* will not often stand critical examination, and genuine comparative investigations seem rare—at least none were met with on these tours.

The Prussian Research Institute has 80 sample plots in uneven aged forests, presumably intended for comparison with the standard even-aged plots, but I was unable to discover any very definite plan underlying the work. The plots are rarely over 2½ acres in extent. It is evident that we shall still have to wait a long time before really satisfying evidence will be available on that much disputed question of the relative yields under selection and concentrated regeneration systems, if indeed the problem is at all possible of general solution.

It is natural in these days of financial stress that the relative costs of natural and artificial regeneration should loom large in viewing the two alternatives, not so much nett costs however computed, but the cash-down costs. It is not only in India that cash expenditure on regeneration works cannot be met out of the sale price of the regeneration fellings, or other sources of revenue, and continental forest officers seem to be experiencing an appreciable amount of the difficulty we always have in convincing the controllers of the public purse that money put into regeneration work is money well invested. This certainly accounted for a swing in favour of natural regeneration noticed in some places, and equally for extensive arrears in cleaning and thinning out over dense masses of regeneration seen elsewhere.

The cost of artificial regeneration work often runs to figures we should consider high in India; thus although line sowings of Scots pine were seen which had cost only Rs. 30/- per acre, ordinary planting operations commonly ran into three figures which was at least locally considered normal for operations at all difficult or out of the normal. Justification was sought in the usually very appreciable gain in time from the best work. Time gained in starting plantations in Europe is viewed not quite so much as a victory in the battle with weeds as is the case in India, though weed growth can be heavy in Europe too, but as a saving of one or more years' increment. For second quality

spruce, as an example, one year's increment at 100 years is about 160 cubic feet per acre adding about Rs. 50/- to the value of the crop which goes a long way towards justifying necessary extra expenditure at the start. Such justification however does not produce the extra money, which is the present difficulty, and it is a natural consequence that every attempt should be made to get the growth without the expenditure, and to explore all possible lines which may lead to lessened expenditure. That cheaper planting methods may sometimes make less difference to the growth than commonly believed was demonstrated by some experiments on notch planting by Dr. Münch at Tharandt which compared well with the customary much more costly pit planting of the controls.

The same principles of course come up in comparing artificial with natural regeneration, but here the time lost is liable to be much greater, and the problem is altogether more complex. In India at the moment we are tending to lengthen our regeneration periods, calling for more patience. This means of course that a varying proportion of the regeneration coupe is not fully stocked and therefore is probably not putting on the full increment possible. Even admitting that we are getting valuable light increment on the selected good overwood stems, it is doubtful whether this can make up for what is lost in waiting many years for the new crop to get started. Figures will become available for representative instances to enable us to consider the point with facts instead of ideas to support our conclusions, but in the meantime it is perhaps best that we should admit that we are probably losing time and money and so keep in mind the need for improving our methods.

The general impression has been gathered from the literature and from examples seen, that there are areas in Europe where regeneration cannot be considered difficult (though of course capable of failure with wrong handling), and it is in these that the more elaborate systems which figure so much in text books and periodic literature have been developed. With skill and experience, variations and combinations of these systems will extend in successful application into more difficult areas but there will always remain, the writer

believes, areas where under whatever method, natural regeneration will be slow and uncertain with a big element of luck depending on weather and seed years.

Long experience appears to underlie most of these methods, as is suggested by the fact that they are usually associated with the name of a leading exponent. They are of course the outcome of long continued experimental work carried out, not as a rule by officers expressly detailed for research work, but by divisional officers with special interest and ability in that direction, remaining in one charge long enough to see the results of their work. This is undoubtedly the chief reason for the small number of special investigations met with on the tour, but among these, three serve well to illustrate special points and tendencies and so may be referred to in some detail.

One is Dr. Busse's investigation on the natural regeneration of spruce under the wedge system. The overwood is a plantation outside the natural distribution area of the species notably in altitude, and somewhat difficult conditions for seedling establishment prevail. The interest to us is not so much the wedge system as such, as the experimental technique developed to study the problem. In general terms, it might be said that the methods adopted are almost identical with those we have arrived at entirely independently in India. There was the same preliminary analysis of the problem with repetitions aiming at covering the controllable variables and providing against the possibility of the results being obscured by the unknown and uncontrollable factors such as soil variation. Progress is recorded on indicator plots as with us. I thought however that spacing as well as numbers of seedlings required more consideration, just as we have realised in India, and I believe photographic records were inadequate or wanting.

The second study has already been described, that of Dr. Fabricius of Münich into the relative rôles of light and root competition in regeneration problems. It is mentioned again as an illustration of a general tendency of the times towards a realisation that we need a much more intimate knowledge of these physiological aspects of the development of seedlings, trees and crops. Regulation of the distribution of the incident light between overwood, underwood, and

regeneration, and between the individuals of each storey will always remain the keystone of our management technique for the simple reason that light is the factor which we can most easily assess and control, but we are being forced to admit an increasingly important part to soil conditions which for the most part we can only measure and alter by indirect means. Root and soil studies have been made of late and are in progress in all countries which realise the need for and value of research, and notwithstanding the difficulties steady progress is being made.

The third investigation has also been mentioned before in connection with soil studies, being Drs. Oelkers and Suchting's work on beech regeneration with which Hole's work in India on *sal* regeneration can well be compared in many respects. This study is once again of interest to us mainly from the point of view of method. With regeneration varying greatly in amount and vigour from place to place in the coupe, the factors likely to be most influential were determined for each of a large number of samples with a view to analysis for correlation of state of regeneration with each of the variables dealt with. As the study was primarily on soil conditions, the latter were correlated with the canopy or light factor. Tentative conclusions were reached and were then tested under the controlled conditions of the laboratory glass-house with resultant confirmation or reference back to the actual plots for further consideration. In this instance, the definite result was reached that the best effects were to be obtained by lightening the canopy at three-yearly intervals, and that the chief agency through which this procedure reacted on the regeneration was the rate of decomposition of the humus, which remained at the optimum with the procedure stated. A permissible deduction is that other forms of treatment which similarly affect the humus will be favourable to regeneration (it might be periodic burning or soil working in other examples), the relative part played by incident light still requiring determination.

Thus we see that in India, the investigations in progress on regeneration problems—and with them, on problems of silvicultural management—can stand comparison with comparable work in Europe

as far as the professional forester alone can take them. We are at present handicapped in our relative lack of facilities for intensive studies in co-operation with experts in allied sciences, and by the circumstances preventing competent officers from remaining in one charge of a limited area long enough to get to know it as well as their European confreres know their charges.

NOTES ON THE PRESENT SHELLAC MARKET.

BY A. K. ADHIKARI, P.F.S.

1. It may be of interest to the readers of the *Indian Forester* to know something about the present shellac market and steps recommended by the Indian Lac Cess Committee to meet the crisis which has arisen due to the rivalry of synthetic resins produced by the chemical industries of Europe and America. It has been held by many that the declining demand for shellac is due to the world's trade depression, but it is not due to that alone. The synthetic resin, in addition to its own virtues, possesses some of the properties of shellac (natural resin) and actually it is being used in manufacturing articles for which formerly shellac had been used, such as grinding wheels and hats. The gramophone record and varnish industries, which consume the greater part of shellac production, have still stuck mostly to natural shellac, but it is doubtful how long their conservatism will keep them away from the various new compounds coming into the field.

2. The difficulty in the shellac industry is that the manufacturers are far away from the consuming industries. It may safely be said that India is the supplier of the world's shellac and that almost all lac is sent out in the form of shellac, though lately an increasing demand has been noticed in the export of seed lac (grained lac or *chowri*). At the same time consumption of shellac in India is insignificant. It is thus evident that the industries for which shellac is exported are non-existent in India. Here lies a great field for the

scientists to find new uses of shellac and for the industrialists to make good their past indifference.

3. The biggest buyers are the United Kingdom, the United States and Germany. India derived a very good income from shellac, the average normal export being 6,00,000 maunds per annum. It may be pointed out that the price of shellac at one time was as high as Rs. 260/- per maund of T. N., whereas it is now about Rs. 20/- to 22/- per maund. It was the drop from this unhealthily high price, coupled with the fact that the Indian manufacturers did not always look to the quality, that has stimulated the research into the possibilities of synthetic substitutes which the Indian Lac Cess Committee are now carrying out.

4. It may be asked why Namkum Lac Research Institute, which has been in existence for some time past, has not looked in this earlier, but it was not realised until lately that the synthetic resin was making such inroads into the natural shellac market in Europe and in America. Besides the earlier activities of the Institute were confined mostly to improving and increasing the lac cultivation in India, and very good results have been obtained on the cultivation and entomological sides and some excellent literature has been published by the Institute. But the low price of shellac and the fall in demand have now called for a different line of research, and the Institute has now concentrated on investigating the technological and manufacturing side. But as already said the difficulty with this industry is that the manufacturers are not in contact with the consumers, and the former do not and cannot supply the latter's needs. So the Institute is now to establish contact through sceintists working abroad in co-ordination with Namkum. What is wanted is to have researches right in the centres of the consuming industries, if possible in their laboratories, and also to study the usage of synthetic resin, to find new uses of shellac and its derivatives, and to develop propaganda work to advertise the properties of natural shellac. It has been decided by the Indian Lac Cess Committee that 3 Indian scientists should be deputed to England and one to America. By paying some contribution to the American Shellac Research Bureau, it in return would admit our scientist and give us

the results of their researches for the benefit of the trade and future use in India. For these researches abroad extra revenue is wanted. With the present income derived from the cess, it is not advisable to divert any money that is paid to finance the Namkum Institute. It has, therefore, been decided by the Indian Lac Cess Committee that the Government of India should be moved to amend the Lac Cess Act of 1930 by raising the cess per maund from -/4/- to -/7/- on shellac and seed lac and from -/2/- to -/5/- on *kiri* lac. In order to avoid duplication of results already obtained at the Namkum Research Institute. the Director will control the work abroad through the president of the Lac Cess Committee with the object that research abroad should not be to interfere with the programme at Namkum but to supplement it by further researches in consultation with the consuming industries. It must not be thought that no attempt has previously been made to establish *liaison* between Namkum and England. Actually the Bihar and Orissa Government appointed a Lac Inquiry Officer in England, but he had no facilities for carrying out actual research in a well equipped laboratory, which is now considered as essential.

5. It may be said that the low price has been a blessing in disguise. It has driven us to take up work which is long overdue. The price of shellac is now about Rs. 20/- to Rs. 22/- per maund, and that of synthetic resin is Rs. 40/- to Rs. 50/-. This is the most opportune moment to recapture the industries from where lac has been ousted by synthetics. It is obvious that unless the lac industry is saved and the market revived, India will lose a huge income, and further it may be that when India develops industrially like Europe and America, she may not find the lac cultivation in existence to meet her own requirements.

FINANCIAL PROSPECTS OF DEPARTMENTAL *TAUNGYA* IN HALDWANI (U. P.).

BY D. STEWART, I.F.S.

In spite of all that has been written on the subject, the problem of obtaining *sal* regeneration in vast areas of the U. P. forests still

remains unsolved. Strenuous efforts towards finding a solution of the problem are being made, but it is realised by most Forest Officers that no rapid solution is likely, and that it will be many years before we are able to carry out regeneration fellings with any confidence of regeneration resulting from them. Meanwhile we are left with large areas of mature growing stock the retention of which pending a solution of the natural regeneration problem will entail a heavy financial sacrifice, and for this reason our efforts during the last few years have been concentrated not only on the problem of natural regeneration but also on the problem of obtaining cheap artificial regeneration. Previous to the last two years it was considered that the cost of making *sal* plantations was prohibitive financially except in divisions where *taungya* cultivators were easily procurable. Strenuous efforts were and are being made to introduce ordinary *taungya* in many divisions where this was previously considered impossible and these efforts are meeting with a gratifying measure of success. There are, however, still divisions in which it is extremely difficult to get ordinary *taungya* going satisfactorily owing to various reasons, but where it is quite possible to do *taungya* departmentally, and it is with a view to indicating the probability that departmental *taungya* with selected crops is likely to be fully as good or even a better solution than ordinary *taungya* that the present article is written, and also in the hope that Forest Officers in other provinces who have had experience of the subject will give their views on a matter which is now of the greatest importance in the U. P.

Our first experience of either of the above methods in this division was obtained during the present year, 1932. Ordinary *khair* plantations without *taungya* have been formed successfully on a large scale for the last 6 years. The cost is now about Rs. 40/- per acre for annual areas of 200 acres. Hitherto no *sal* plantations had been formed except for a small experimental area of 15 acres done by the Research Circle in 1931 in Lakhmanmandi C. 4 with *boga medeloa* between the lines to keep down grass. The cost of this up to date is well over Rs. 100/- per acre. *Boga medeloa* has no market other than a very limited demand for the seed from tea gardens in Assam. More

than enough to supply this demand is available locally in Assam and Bengal, so in the U. P. *boga* seed is unsaleable. Silviculturally *boga* is satisfactory in so far as it absolutely keeps down all grass. It is, however, not cheap to raise between the lines as it requires soil scratching before sowing, and normally two complete weedings in the first rains to allow it to compete with the grass. At the beginning of the second rains it must be cut back completely, otherwise it grows into an enormous shrub and completely suppresses the *sal* and partially suppresses the *khair* in adjoining lines.

In 1932 cotton was tried on a small scale between *sal* lines in Sela C. 2 and between *khair* lines in Lalkua. In both cases the silvicultural results have been excellent. The *sal* and *khair* in the cotton areas are, if anything, better than in other parts of the plantation of the same year. The cotton has completely killed out all grass between the lines, so that the rate of growth of both *sal* and *khair* ought to be particularly good in the second year. In both cases only two weedings of cotton were necessary during the first rains, *i.e.*, the same number as is required for *boga medeloa*, but whereas there is no financial return from *boga*, the cotton in the Sela area was sold for Rs. 43/- per acre and in Lalkua for Rs. 16/- per acre. Not only so, but the cotton crop can now be cut back and will give another crop in the second year which ought to fetch about Rs. 20/- per acre. It should be noted that the price obtained for the Sela cotton is rather on the high side and the contractor who purchased it will probably incur a slight loss. The real price is probably somewhere in the region of Rs. 30/- per acre. The low price of Rs. 16/- per acre obtained for the Lalkua cotton is no indication of the real price of cotton in this area as the cotton was not sown till August, at least a month too late. Consequently, it flowered and seeded late and the flowers and floss were affected by the cold atmosphere and heavy dew at the beginning of the cold weather. I am confident that if this cotton had been sown a month earlier, it would have fetched Rs. 30/- per acre. It is, therefore, anticipated that during the first two years cotton will yield a revenue of about Rs. 50/- per acre. In the *khair* plantations cotton cannot be grown for more than two years as the *khair* plants will be too high

by the end of the second year, but in *sal* plantations a new cotton crop could be introduced in the third year and give a further revenue in the third and fourth year of say Rs. 40/- per acre at a further cost of about Rs. 20/- per acre for seed, soil preparation, sowing and weeding.

The total revenue therefore obtainable from cotton should be roughly as follows :—

Sal plantation—Rs. 90/- per acre in the first 4 years.

Khair plantation—Rs. 50/- per acre in the first two years.

I now give details of the anticipated expenditure of forming *sal* and *khair* plantations with cotton between the lines :—

Sal plantation of 50 *acres.*

I take an area of 50 acres because this is the largest sized area we have yet tackled in this division for *sal* plantations, and I can give more accurate figures of costs for such an area. For an area of double the size the expenditure per acre would be considerably less.

	Cost per acre.	
	Rs.	a.
(1) Clearing and burning felling débris	2	0
(2) Soil preparation for *sal* and cotton	13	0
(3) Cost of cotton seed	2	0
(4) Collection of *sal* seed	1	8
(5) Sowing cotton and *sal*	3	0
(6) Weeding cotton and *sal*	10	0
(7) Erection of deer proof and porcupine proof fence	6	0
(8) Cost of new wire for fence (wove wire, netting wire, barbed wire)	28	0
Total cost ..	65	8

With a cotton crop on the ground very little weeding of *sal* will be required in the second year but Rs. 5/- per acre may be allowed for this. In the third year there will be an expenditure of about Rs. 20/-

per acre for the reintroduction of the cotton crop. The total expenditure to the end of the 4th year should therefore be about Rs. 90/8/- per acre. As the cotton is estimated to fetch a revenue of Rs. 90/- per acre in the first 4 years, it looks as if the formation of *sal* plantations on the scale of 50 acres per annum will cost us nothing. With areas of 100 acres or more there should be a definite profit on formation. It seems therefore that departmental *taungya* with cotton is going to be a much more profitable proposition than giving the land free for ordinary *taungya*. With the incidence of deer and porcupine as heavy as it is in Haldwani, it is almost certain that a fence which is proof against deer and porcupine will always be necessary for *sal* areas, and at present *taungya* cultivators (and these in numbers which are not sufficient to deal with the total area we wish to do annually), can only be induced to come in if such fences are erected departmentally. This means a departmental expenditure of Rs. 34/- per acre, if new wire is used, but as the wire can normally be used again in a subsequent area, the real cost may be put at Rs. 20/- per acre plus Rs. 2/- per acre for the clearing and burning of felling *débris* which *taungya* cultivators cannot, up to date, be induced to do here. It looks, therefore, as if for some time to come we must reckon on a departmental expenditure of Rs. 22/- per acre with ordinary *taungya* whereas with departmental *taungya* it appears that we can make enough revenue off the cotton crop to recover all formation costs or even make a profit.

Second only in importance to the regeneration of our *sal* forests is the problem of regenerating our valuable miscellaneous forests in this division. These do not regenerate naturally to any great degree and it is essential to replace artificially at as low a cost as possible the amount we are felling annually, as the market for these miscellaneous timbers is steadily expanding and they are no mean capital asset.

Khair and semal plantation of 200 *acres.*

I here take a 200 acre area as we are actually doing *khair* and *semal* plantations of this size now in this division annually with complete success.

	Cost per acre. Rs.	a.
(1) Clearing and burning felling *débris*	1	8
(2) Soil preparation for *khair*, *semal* and cotton ..	13	0
(3) Cost of cotton seed	2	0
(4) Collection of *khair* and *semal* seed	1	0
(5) Sowing cotton, *khair* and *semal*	2	0
(6) Weeding cotton, *khair* and *semal*	9	0
(7) Erection of deer proof and porcupine proof fence	4	0
(8) Cost of new wire for fence ; wove wire, netting wire, barbed wire	14	0
Total cost per acre ..	46	8

With a cotton crop on the ground very little weeding will be required in the second year and it will suffice to allow Rs. 2/- per acre for this purpose, making the total cost of formation Rs. 48/8/- per acre.

As the cotton crop is estimated to give a revenue of Rs. 50/- per acre during the first two years it means that we should slightly more than recoup our formation cost from the cotton, including the cost of fencing. If we give the land out for ordinary *taungya* cultivation to cultivators we should almost certainly have to fence the areas departmentally against deer and porcupine, as *khair* is most greedily browsed by deer, and *semal* equally greedily devoured by both deer and porcupine. We would also have to clear and burn felling *débris*. This would cost us Rs. 12/8/- per acre assuming the wire is used twice. Thus with *khair* and *semal* plantations, as with *sal*, it looks as if departmental *taungya* with cotton is going to be the more profitable proposition. Also the introduction of ordinary *taungya* in these areas is a more difficult proposition than in our *sal* areas. With so quickly growing a species as *khair* the area can only be cultivated for 2 years and being on the edge of the dry *bhabar* tract there are difficulties about water-supply both for domestic consumption and irrigation in a year of deficient rainfall. So far we have been unable to induce any cultivators to do *taungya* in these areas and it is therefore pleasant to realise that the financial prospects of departmental *tungaya* are so promising.

As we have at present insufficient data on which to base definite conclusions our policy is to continue exploring both the lines of pro-

cedure indicated above as carefully as possible, doing part of our areas departmentally and part by ordinary *taungya*. It would, however, be particularly interesting if Forest Officers in other provinces who have had experience of the subject would give their views. I understand cotton is a crop which is liable to be attacked by pests and to be affected by the particular weather conditions prevailing at the time of flowering. Results obtained with cotton elsewhere would be particularly interesting.

GOVERNMENT SAWMILLS IN BOMBAY PRESIDENCY.

BY T. K. MIRCHANDANI, A.C.F.

Short history of the industry.—Before attempting to describe the various phases in the development of the sawmilling industry of the Forest Department, it would not be out of place to give a brief synopsis of its history in this presidency. From the records available in this office it appears that the first government sawmill started work in 1874-75 at Yellapur. Later, more sawmills were opened. The following table gives the location and the period of work for the various sawmills :—

Name of place.	Date of erection of the mill.	Date of closing of the mill.	REMARKS.
1	2	3	4
	Southern Circle.		
	Kanara Northern Division.		
Mynol ..	1906-07	1909-10	Transferred to Shingatgeri.
Shingatgeri ..	1910-11	1912-13	Transferred to Gobral.
Gobral ..	1913-14	1915-16	Transferred to Kumbarkop.
Do. (2nd mill)	1914-15	1915-16	
Kumbarkop (2 mills)	1916-17	1917-18	Transferred to Dandeli.
Sambrani ..	1915-16	1924-25	Transferred ta Bomanhalli.
Dandeli ..	1917-18	Working at present.	A new American log mill added in 1930-31.
Bomanhalli ..	1924-25	1928-29	Engine transferred to Kirwatti and old machines scrapped and sold. Serviceable machines and tools transferred to Foden and Fowler mills.

Name of place.	Date of erection of the mill	Date of closing of the mill	REMARKS.
1	2	3	4
Foden Portable at Bomanhalli.	1928-29	Working at present.	Driven by Foden steam tractor (originally purchased for road transport). The machines are borrowed from old Bomanhalli and Dandeli Mills.
Fowler Mill at Mandurli.	1931-32	Do.	Worked by old engine of Dandeli Mill. Machines are borrowed from old Bomanhalli and old Dandeli Mill.
	Kanara Western Division.		
Tambepar ..	1918-19	1925-26	Transferred to Haste (Peint), Northern Circle.
	Kanara Eastern Division.		
Yellapur ..	1874-75	1898-99	Transferred to Ittinbail.
Ittinbail ..	1899-00	1901-02	Transferred to Kirwatti.
Kirwatti ..	1902-03	1902-03	Transferred to Kannigeri.
Kannigeri ..	1903-04	1905-06	Part of equipment transferred to Mynol.
Kirwatti ..	1917-18	Working at present.	A new American log mill added in 1929-30.
	Kanara Central Divison.		
Ramanguli ..	1918-19	1922-23	Scrapped. Engine and part of equipment transferred to Dandeli.
	Northern Circle.		
	Dangs (Surat Division).		
Jharan ..	1913 14	1914-15	Transferred to Muramvihir.
Muramvihir ..	1914-15	1917-18	Transferred to Subir.
Subir ..	1917-18	1921-22	Transferred to Karanjada.
Karanjada ..	1921-22	1926-27	Finally closed down and sold.
Chikalda ..	1922-23	1930-31	Transferred to Sunda.
Sunda ..	1930-31	..	Working at present.
	Peint (Nasik District).		
Badgi ..	1923-24	1929-30	Purchased from P. W. D., finally closed down.
Haste ..	1925-26	1931-32	Obtained from Tambepar and finally closed down.

In the beginning each sawmill was an individual effort. There was no co-ordination, nor any definite policy nor organised arrangements for repairs and upkeep of machinery and for the supply of stores etc. Each Divisional Forest Officer looked after his sawmill and made arrangements for supply of sawmill stores and for repairs of machinery as well as he could. In brief, the sawmills were run as badly or/as well as some of the sawmills run at present by petty contractors. For their mechanical efficiency the Divisional Forest Officer had to rely on the foreman in charge of the mill, who was usually a man with very elementary knowledge of boiler work and held a 3rd class certificate of the Boiler Inspection Department under the Indian Boiler Act. Naturally under such an arrangement the mechanical efficiency of the sawmills was not very high and this was reflected in the financial returns of the sawmills.

The demands of the Great War gave a fillip to this activity of the Department and in 1920-21 (the great boom year of modern times), a full fledged saw doctor was imported to look after and organise the mechanical side of the sawmills, and the authorities began to realise the necessity of organizing the sawmill work and handing over their running to men who knew their job. From 1921-22 to 1923-24 the sawmills were gradually transferred to the Forest Engineering Branch of the Forest Department and it was not till 1923-24 that for the first time the money for purchase of sawmill stores, plant, etc., was provided for in the Engineering budget. In 1927-28 the responsibilities of the Forest Engineer in respect of sawmills were clearly defined in a Standing Order by the Chief Conservator of Forests. The present arrangement is that the Forest Engineer is responsible for the running, upkeep, and general mechanical efficiency of all the engines and machinery of sawmills and to make arrangements for supplies of sawmill stores. The Divisional Forest Officers concerned control the staff and look after the business side of the sawmill management, *i.e.*, the supply of raw material (timber in the round) and the sale of finished produce, *i.e.*, sawn timber etc. The arrangement is not an ideal one but is probably the best under the circumstances and has so far worked fairly satisfactorily.

Equipment and Work of the Mills.—For the purpose of these notes the sawmills in this Presidency may be divided into *Portable* and *Semi-Portable.* Under the former class are included sawmills for which motive power is supplied by a mobile engine (a steam or internal combustion motor engine) and are self-contained for the transport of their equipment from one site to another. We have one such sawmill equipped with a powerful steam road tractor complete with a 4-ton trailer for transport of mill equipment. To the latter class belong the remainder of our sawmills. These are also portable mills except that the motive power for transport from site to site is either draught animals or a steam road engine. The portable mills are housed in temporary sheds, but the semi-portable mills are erected in corrugated iron sheds Such mills are removed from one sphere of work to another after about 7 to 10 years depending on the fellings in the locality. At present the following sawmills are working in this Presidency :—

1. Dandeli Sawmill .. (Semi-portable, but more or less permanently stationed at Dandeli).
2. Foden Mill .. (Portable, at present stationed at Bomanhalli).
3. Fowler Mill .. (Semi-portable, stationed at Mandurli).
4. Kirwatti Mill .. (Semi-portable, but more or less permanently stationed at Kirwatti).
5. Badgi Mill .. (Semi-portable, closed down recently).
6. Haste Mill .. Do. do.
7. Dangs Mill .. (Semi-portable, stationed at Sunda).

Dandeli Mill is engaged principally on special M. & S. M. Railway indents and for the supply of metre gauge teak wood railway sleepers,

For the former it is usual to saw saleable timber logs in the round, while for the latter special sleeper pieces obtained from odds and ends in the logging operations of the division are sawn. The Foden portable and the Mandurli Sawmills do only sleeper cutting work. The raw produce for them is obtained from the fellings around their present sites. The Dandeli Mill is not working up to its full capacity. The outturn of this mill (up to the limit of its full capacity) would depend on the number of railway indents and sleeper contracts secured by the mill. It does not pay to saw up logs for stock sizes. As an experimental measure we have two small circular benches cutting railway keys installed in this mill. The Kirwatti Sawmill does mainly sleeper cutting work although a few occasional railway and private indents are also executed by this mill.

The 3 sawmills of the Northern Circle (two in Peint and one in Dangs) saw mainly waste timber from fellings, *i.e.*, they convert the odd lengths of branchwood and unsound stem-wood and butt-ends left over in a felling area after all the timber worth extracting in the log has been removed from the coupes. The second sawmill of Peint was closed finally last year as contractors did not come forward to purchase standing crops in the coupes at attractive prices and also because, in the absence of an outlet to the sea, the above-*ghat* market at *Nasik* was not able to absorb the output of the Peint Mills.

The Dangs Mill was lately situated at Chikalda (South Dangs). It completed its programme of work and was transferred to its present site (at Sunda, Central Dangs, 18 miles from the railhead at Waghai) in July 1930. It is expected that the mill will remain in its present locality in Khapri valley for the next 10 years.

The following are the usual duties of a sawmill engineer :—

(*a*) Maintenance of machines, gear and equipment in good repair and in working order.

(*b*) Introducing improvements where practical experience has indicated any change in design necessary.

(*c*) Maintaining timely supply of stores of most suitable quality.

(*d*) Exercising a check over consumption of stores to ensure economy in their use.

(*e*) Checking mill store accounts, labour bills, and output with a view to watch the sawing costs and detect in what particular direction economy could be effected.

(*f*) Collecting full data from which to obtain a guide for future improvements. This work is done in detail and has been found to be of the greatest value in throwing light on causes of inefficiency and waste.

(*g*) Maintaining the output at maximum capacity for each sawmill. For this purpose a minimum daily standard output for each branch is fixed. This depends on the kind of work performed by each unit, *e.g.*, the standard output of a sleeper sawing mill is naturally more than one engaged on cutting boards etc.

(*h*) Instructing the establishment in systematic and correct methods of work in the mill.

Saw blades are the most important and expensive individual item of sawmill stores if they are not properly looked after. On their proper sharpening and care depends the output and efficiency of a sawmill. The correct profile of tooth most suitable for teak wood is given to each saw-sharpener and they are made to conform to it. In some of the mills where the foremen in charge are trained men special saw tensioning tools are also provided.

Safety precautions.—All saw machines and belt drives are protected with saw guards and covers as provided under the Indian Factory Act and all reasonable precautions are taken to prevent accidents. During the last 10 years there have been only two minor accidents to the labour employed in our mills and these were primarily due to the carelessness of the men injured. An Inspector of the

Factory Department inspects each sawmill every year. The boilers of the engines are also inspected by an inspector of the Boiler Department and all repairs pointed out by him are carried out to his satisfaction.

Seasoning sheds.—Practically all the sawmills are provided with seasoning or storage sheds. In most cases the capacity of the sheds is not commensurate with the output and stocks of sawn timber held in storage pending sales. Gradually as the funds permit the storage capacity of these sheds is being increased. The Engineering Branch has designed two types of seasoning sheds (one with steel truss roof and another with wooden truss roof) for this purpose.

Lay-out.—As has already been stated the sawmills of this presidency were not started on any preconceived plan. Naturally therefore the lay-out is in most cases unscientific and uneconomical. The mills have simply " grown " by additions made to them from time to time with the result that in many cases they have a very peculiar and conjested lay-out. In some cases the raw produce enters the mill at both ends, and the finished product and waste material collect right in the centre of the mill. Removal of these requires expensive manual handling. In a properly designed sawmill the raw produce enters at one end and the waste product and finished material leave at the other. In such a lay-out the transport of materials through the works is done as far as possible with the aid of labour-saving mechanical devices like live rollerways, dead rollerways, gravity trolleys, dust conveyors etc. This is achieved by designing the mill and its various components on their proper levels in order to minimise the lifting of heavy baulks of timber. Similarly in larger mills mechanical endless chain drives are utilised for sorting out the finished timber and for transport to a suitable dumping ground of sawdust and other waste. In the lay-out of the newly erected sawmills, *e.g.*, the Dangs Sawmill, this object has been kept in view and cross handling of material is avoided as far as possible. The lay-out of the Dandeli and Kirwatti Sawmills is under revision, and revision of the lay-outs of the remaining mills will be taken in hand in due course,

Output and financial aspect.—The following figures show the development of sawmilling in this Presidency during the last 10 years :—

Year.	Output of sawn material in c.ft.	Cost per c.ft. excluding overhead charges, *e.g.*, depreciation and supervision.	REMARKS.
1922-23 ..	1,60,000	Data not collected.	
1923-24 ..	2,66,000	Do.	
1924-25 ..	3,13,000	7·71 annas.	
1925-26 ..	3,08,500	6·12 ,,	
1926-27 ..	3,88,659	5·82 ,,	
1927-28 ..	4,17,480	4·98 ,,	Average for last 5 years 4·81 annas.
1928-29 ..	3,34,753	5·42 ,,	
1929-30 ..	3,05,997	4·96 ,,	
1930-31 ..	3,28,018	4·48 ,,	
1931-32 ..	3,32,616	4·16 ,,	

It is interesting to note that the conversion costs are progressively decreasing from year to year. Comparing the average figure for the last 5 years with the figures for 1924-25, the economy in sawing costs per cubic foot is 7·71 minus 4·81 = 2·90 annas. Taking the average output for the same period the savings on account of these costs alone amount to over Rs. 62,000 per year. This represents a total saving of nearly five lacs of rupees in working costs accruing to the department by the improvements introduced by the Engineering Branch since 1924-25. But for the constant co-operation of the Divisional Forest Officers under whose immediate control the mill establishment are working such splendid results would have been quite impossible to attain.

The chief factor which affects the cost of conversion is the output of the mill. The reason for this can easily be explained. The labour and establishment charges are practically constant whether a sawmill is working at its full pressure all the time or slowly. Only the issues of stores like lubricants, saw blades, emery wheels etc. would proportionately decrease for decreased output. It is therefore important to fix the rate of output per bench at its full theoretical capacity and then make every effort to maintain it. Of course it must be recognised that the sawmills are meant to effect economy in forest

exploitation and under no circumstances should the principles of sound forestry be subordinated to the objects of economic exploitation, but given a set of machinery and equipment every effort should be made to work it to its full capacity. It is obvious that it would be cheaper in the long run to scrap some of the machines and maintain a small sawmill working at its maximum capacity rather than a large sawmill which is not working at full pressure.

The following are excerpts from the review of the working of Government sawmills for the year 1930-31 :—

"During the year 559,099 cubic feet of timber in the round principally teakwood valued at Rs. 2,73,518 (royalty) were converted in Government sawmills as compared with 554,909 cubic feet dealt with last year. The total output during the year was 328,018 c.ft. as compared with the output of 305,997 c.ft. of the previous year. The estimated gross value of this amounts to Rs. 5,78,119/-, and including miscellaneous receipts of Rs. 4,726/- the total gross receipts amount to Rs. 5,82,845/- as compared with the gross receipts of Rs. 7,69,827/- during the previous year. This reduction in gross receipts is the result of lower prices realised during the year due to general trade depression. The total labour and establishment charges for the year amount to Rs. 75,561/- as compared with Rs. 78,679/- last year. This works out at 3·69 annas per cubic foot of sawn material as compared with corresponding charges of 4·11 annas per cubic foot last year. The costs on account of the stores this year work out at 0·99 annas per cubic foot as compared with 1·49 annas being the corresponding figure for last year."

"The total fixed capital (which includes cost of tools, plant and buildings) invested in all sawmills amount to Rs. 2,61,819/- this year as compared with Rs. 2,72,992/- last year. This is depreciated at 5 per cent. for machinery and 2½ per cent. for permanent buildings. The depreciation reserves amount to Rs. 1,20,060/- on 31st March 1931." These reserves are merely imaginary as there is no depreciation fund maintained by Government.

"The total overhead charges during the year amount to Rs. 1,00,013/-. These include items such as salary and allowances of

supervising establishment and part pay and allowances of the Forest Engineer, miscellaneous charges like repairs to buildings, boiler inspections, carting of sawn material, postal charges etc., etc." The charges on account of depreciation on fixed capital and interest on the fixed and floating capital are also included under this head. "The total estimated gross profits on the year's working amount to Rs. 2,13,387/-." After meeting the overhead charges the net profit amounts to Rs. 1,13,374/- as compared to Rs. 2,32,093/- last year.

Taking into the account the fact that most of the sawmills convert timber which would ordinarily be unsaleable (*e.g.*, the *débris* of the logging operations etc.), and for which they pay to the divisional revenues the average royalty rate realised on sound timber in that locality, the profits shown above are really only a part of the actual financial benefit to the Department on account of these sawmills. It will thus be realised that the Government sawmills in this Presidency are a profitable proposition in spite of the unprecedented worldwide trade depression and anti-Government agitation during the year under review.

Future Prospects.—Although the results recorded above are highly satisfactory, there is no doubt that there is still room for improvement in the organisation of mill labour. As far as the stores charges are concerned, considering the local conditions the costs have been kept down to the minimum. In future establishment and labour charges are likely to rise owing to the difficulty of getting properly trained men to stay in out-of-the-way and malarious localities where our mills are usually situated. Daily labour rates have also a tendency to rise from year to year, therefore it is most essential that the number of labour units employed in our mills should be reduced to the minimum which in other words means that each individual should turn out more work than he does at present. This is possible with better organization of labour in the mill and by adoption of labour saving devices like tramways, trolly feeds, automatic feeds etc. It is also essential that the labour employed should be housed properly with all the necessary sanitary arrangements for a labour camp.

Choice of Power Unit.—All our sawmills are run at present by steam engines. There is no doubt that steam power units are by far the most suitable prime movers for running jungle sawmills. Their chief defects are excessive weight per horse power developed and the necessity of providing unlimited supplies of water. This limits the choice of sites for sawmills. On the other hand a Diesel type tractor would be ideal for a really portable sawmill, but the rate of depreciation and running costs of a motor tractor as compared with a steam engine (which draws its fuel free from the sawmill) are high. The average life of a steam engine is anything from 25 years to 30 years while the average life of a superior quality tractor would be about 10,000 hours or say 5 years at 8 hours per day and 290 working days per year.

In contrast to a steam engine the motor tractor power unit is highly mobile but its overload capacity is almost nil in comparison with tne flexibility of a steam engine. On the whole for sawmills which have not to change their locations every year steam tractors are superior to Diesel tractors.

LYCTUS BEETLES IN INDIA.

BY C. F. C. BEESON, I.F.S.

The protection of wood used for boxes, packing material, plywood, tool handles, furniture, etc. from damage by *Lyctus* or Powder Post Beetles is one that exists in every country. In a sense it is an international problem, since these borers are very readily transported in timber from one country to another, and may, if the new conditions prove suitable, establish themselves permanently. India has so far suffered very little from introduced lyctids, but there is a growing danger of some of her timbers falling into disrepute in foreign countries on account of their liability to infestation by lyctids and to the importation of lyctids in them.

In collaboration with the Forest Products Research Laboratory, Princes Risborough, England, the Forest Research Institute, Dehra Dun, is undertaking a survey of the distribution and food-plants of indigenous lyctids in India, with particular reference to those species

established in timber depots, and in the principal ports from which Indian timbers are shipped abroad. As a preliminary step the information on Indian lyctids previously collected by the Branch of Forest Entomology has been summarised and is now published. The Forest Entomologist will be very glad to receive from any source samples of timber attacked by Powder-Post Beetles, so that the various species may be reared at Dehra Dun and properly identified.

The lyctids known to occur in India are :—*Lyctus africanus, L. brunneus, Lyctoxylon japonum, Minthea rugicollis, Trogoxylon auriculatum, and T. spinifrons.*

Lyctus africanus Lesne.

Distribution.—This African insect is the commonest lyctid in northern India and is found from the western Punjab to Bengal. It is not clear whether the species is permanently established in the hotter and moister regions of south India. Although it has been bred at Dehra Dun from many logs of timber sent from the southern provinces it is possible that infection occurred during halts at railway stations on the journey. It is not present in the Andamans and is rare in Calcutta. Samples of infested wood despatched by post are required to settle the question of its natural habitat.

Food-plants.—*Acacia arabica, A. gageana, A. modesta, Albizzia procera, A. stipulata, Alnus nepalensis, Alstonia scholaris, Artocarpus hirsuta, Bambusa arundinacea, Bauhinia vahlii, B. variegata, Bombax malabaricum, Buchanania latifolia, Butea frondosa,* Cane, *Cassia fistula, Cynometra polyandra, Dalbergia paniculata, D. sissoo, Dendrocalamus strictus, Embelia robusta, Derris elliptica, Erythrina suberosa, Ficus glomerata, F. hispida, F. palmata, F. religiosa, F. rumphii, Garuga pinnata, Gmelina arborea, Grevillea robusta, Grewia tiliafolia, Kydia calycina, Lagerstrœmia lanceolata, L. parviflora, Lannea grandis, Macaranga roxburghii, Mallotus philippinensis, Mangifera indica, Melanorrhoea usitata, Milettia auriculata, Parashorea stellata, Pithecolobium dulce, Pongamia glabra, Pterocarpus marsupium, Pterospermum acerifolium, Quercus semicarpifolia, Q.* spp., *Shorea robusta, Soymida febrifuga, Spondias mangifera, Sterculia alata, S. urens, Tectona grandis, Terminalia arjuna, T. belerica, T. bialata, T. tomentosa, Vateria indica.*

Life-history.—The emergence-period of this species is somewhat unstable, but broadly speaking, there is a recognisable regulation due to the factors of temperature and humidity. Our observations are based on material caged in the Dehra Dun insectary in metal and wooden cages with light-traps, and extend over the past ten to fifteen years.

Ordinarily there is very little emergence during the first three months of the year—at the most odd groups of individuals amounting to a small percentage of the annual total. At the beginning of the warm weather there is a fairly sudden increase in the number of emerging beetles, which rapidly rises to a high peak. This phase of abundant emergence usually commences in the first half of May (but may be as early as the middle of April, or as late as the end of May), and lasts for three or four weeks and then falls to relatively low figures.

Beetles continue to emerge for the rest of the year in varying abundance which may increase at one or two periods to numerically high peaks, that, however, are rarely so high as the first peak of the year. When there are two periods of high abundance the second usually commences in July and extends into August and September, and is apparently determined by the increased humidity of the early monsoon season. When there are three periods of high abundance in the annual emergence the second falls in the interval between the beginning and the end of the rainy season; and is followed by a third emergence peak in the cold season between the middle of November and early January. A mild winter may prolong this activity but at a very low level well into March.

As regards the life-cycle of this lyctid there are two aspects to consider from the practical point of view, *i.e.*, the shortest and the longest possible cycles, or, in other words, how soon a piece of infested timber will yield beetles capable of attacking other stock and how long the danger will continue. The developmental cycle of *L. africanus* is on an annual basis in north India; that is to say, a batch of eggs laid in one year is capable of producing mature beetles in the corresponding season of the following year. This, nevertheless, does not preclude the

ability of some of the eggs laid very early (*e.g.*, in April) to yield beetles just before the onset of the following cold weather. The beetles maturing in the first year after egg laying may swarm in greater abundance at three seasons,—hot weather, monsoon, and early cold weather,—but these emerging individuals represent only a portion of the total larval population in the attacked wood. Maturation and emergence continue with the same rhythm in subsequent years, in gradually declining intensity. The longest period over which emergence may extend (as far as our records go) is sixty-six months. This occurred in the case of mango planking used for making opium chests in the Opium Agency, Ghazipur, U.P. Periods of up to fifty-two months have been recorded for wooden tent-pins obtained from Ordnance Depots in Allahabad, Calcutta, Ferozepore, Madras, Karachi and Rawalpindi. Three or four years is quite usual for plywood, furniture etc.

It has not been definitely ascertained if this prolonged period of infestation is due wholly to delayed larval development or partly to reinfestation with eggs laid by emerging beetles, but we believe it to be due, in the conditions instanced entirely to protracted larval development. In the cages used in the Dehra Dun insectary pairing and oviposition, if they occur, would have to take place in darkness against the competition of the external source of light by means of which the newly emerging beetles are trapped.

It has not been proved experimentally that eggs laid on old seasoned wood can develop successfully. On the other hand by felling a series of trees (of *Shorea robusta*) monthly throughout the year, and leaving logs in the forest for various periods it has been discovered that newly felled timber is not attacked during the first month but is readily attacked during the second month after felling.

Lyctus brunneus Stephens.

Distribution.—Andamans : Chatham. *Madras :* Nilambur ; Nilgiris. *Manipur* : Shugnu. *Cosmopolitan.*

Food-plants.—Canarium euphyllum, Erythrina indica, Kydia calycina, Mangifera indica, Terminalia bialata.

Recorded from South India as damaging shooks used for rubber chests and packing cases. It is rare in the Chatham Mill in the South Andamans. Outside India this species is known to attack a very large number of species of timbers particularly in tropical Africa, Malaya and Indo-China. Lesne (1924) says " of all the lyctids this species is the most widely distributed over the surface of the globe. It is probable that man has played a preponderant rôle in its dissemination. To-day it exists at many points in the tropical and sub-tropical regions. Its great abundance and the continuity of its habitat in the Indo-Malayan and Sino-Japanese regions seem to indicate that it originates from these countries." Although our records of its occurrence in India are very scanty it must evidently be rated as a species of potential economic importance.

Lyctus fuscus Linnæus.

This species (=*Lyctus linearis* Goeze et auctt) is reported to be cosmopolitan but I have seen no specimens authentically from India. Although introduced in commercial wood products into many countries of the world it does not appear to have established itself except in regions with climates similar to that of central and northern Europe.

Lyctoxylon japonum Reitter.

Distribution.—Bengal : Sunderbans. *Madras* : Madura ; Nilambur. *Japan. China. North America.*

Food-plants.—Albizzia procera, Bamboo, Cane.

Life-history.—The life-cycle may be prolonged for two years. The longest recorded emergence period extended over twenty-two months from the date of first appearance of beetles. The period of abundant emergence is well defined and lies between September and March (maximum abundance in November-December) in the case of material caged at Dehra Dun.

The species is probably confined to the more humid regions in India. It was reported as infesting the canes used for strengthening bales of yarn belonging to the Madura Mills Co., Ambasamudram, Madras, in company with *Dinoderus brevis* and *D. minutus*. The beetles emerging from the cane bored into the yarn causing considerable damage to it.

It has been introduced into the United States in commercial articles made of bamboo from Japan and China.

Minthea rugicollis Walker.

Distribution.—Andamans: Bonnington and Chatham Mills. *Bengal:* Calcutta timber yards. *Bombay:* Western India Match Factory; Bassein Range, West Thana. *Burma:* Kyundaung Reserve, West Salween. *Coorg:* Mawkut. *Madras:* Madras Ordnance Depot; Coonoor Range, Nilgiris; Nilambur. *Travancore. Central Africa. Malay Archipelago. Australia.*

Food-plants.—Bombax malabaricum, Canarium euphyllum, Canes, *Dipterocarpus turbinatus, Derris elliptica. Erythrina indica, Garuga pinnata, Hardwickia pinnata, Parishia insignis, Phyllanthus emblica, Poinciana elata, Sterculia campanulata, Terminalia bialata, Wrightia tinctoria.*

Life-history.—Wood attacked by *Minthea rugicollis* may yield beetles over a period of more than eighteen months from the time of first emergence. The emergence-period is extended and ill-defined. Beetles appear in greatest abundance in November-December and in June from wood caged at Dehra Dun.

This species is sub-cosmopolitan in the tropics. In India it is commonest in the moister warmer forest regions of South India and Burma. It is the predominant species in the timber mills of the Andamans where it replaces *Lyctus africanus*, characteristic of the northern and drier regions. It has been imported into the Calcutta timber yards in Andamans timbers, but has not spread to the depots dealing with Assam and Bengal woods. It occurs in the Western India Match Factory, Bombay, and has been reared from wooden I. P. tent-pins from the Madras Ordnance Depot.

Trogoxylon auriculatum Lesne.

Distribution.—Madras: Bellary Range, Anantapur; Sappal, Palghat. *Punjab:* Lahore; Rawalpindi. *United Provinces:* Dehra Dun; Kalagarh; Chandi Range, Lansdowne.

Food-plants.—Acacia intsia, A. modesta, Acacia sp., *Albizzia lebbek, A. odoratissima, Bauhinia retusa, Combretum decandrum, Dalbergia sissoo, Erythrina suberosa, Kydia calycina, Shorea robusta,*

Life-history.—This species exhibits a much more sharply defined emergence-period than its allies, swarming in May and the first half of June. The life-cycle is annual. It is a forest inhabiting species breeding in dry wood and not ordinarily present in sawmills and factories; it has been reared from wooden I. P. tent-pins stored in the Madras and Rawalpindi Ordnance depots, but the locale of infection of this material is obscure.

Trogoxylon spinifrons Lesne.

Distribution.—*Bengal:* Calcutta timber yards; Debrepani, Darjeeling. *Bombay:* West Thana. *Central Provinces:* Purna Range, Buldana; South Chanda; Banjar Range, North Mandla; Seoni. *Madras:* Berhampur Range, Ganjam. *Punjab:* Lahore. *United Provinces:* Dhera Dun; Jarwa Range, Gonda; Gorakhpur; Jawalapur, Saharanpur.

Food-plants.—*Acacia modesta, Alstonia scholaris, Anogeissus latifolia, Bombax malabaricum, Boswellia serrata, Buchania latifolia, Careya arborea, Cassia fistula, Dalbergia paniculata, Dendrocalamus strictus, Garuga pinnata, Inga dulcis, Litsœa kingii, Mangifera indica, Prosopis juliflora, Semecarpus anacardium, Shorea robusta, Soymida febrifuga, Sterculia alata, Terminalia belerica, T. tomentosa.*

Life-history.—The life-cycle has not been specially studied but it seems that beetles may mature in six months and emergence may continue for more than fifteen months after infestation. The emergence-period is not very well marked, but the onset of the monsoon causes increased swarming that continues well into the cold weather. Beetles are most abundant from July to December.

The species is not so common as *Lyctus africanus* in most localities, but in some places, as for example the timber yards in Calcutta, it appears to replace *L. africanus* almost completely.

THE LIABILITY OF SOME INDIAN TIMBERS TO *LYCTUS* ATTACK.

By K. A. Chowdhury, Wood Technologist, Forest Research Institute.

Introduction.—It has been shown by Clarke (2) that the size of vessels in a timber determines whether or not it is liable to be attacked

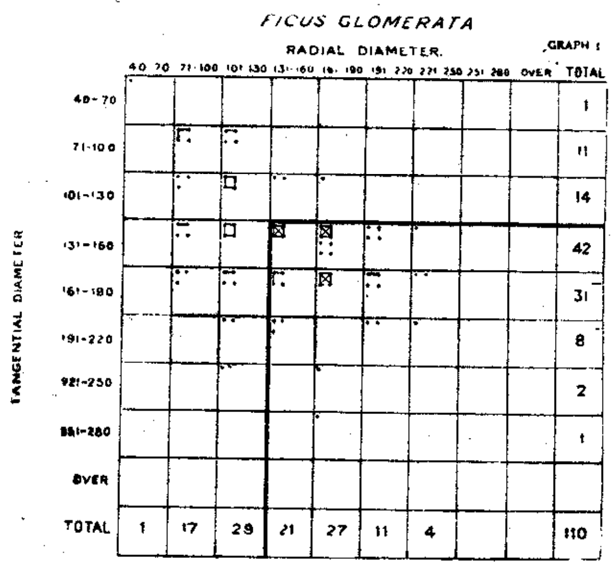
by *Lyctus* beetles. The beetle can lay eggs only in those timbers in which the size of the vessels is larger than that of the eggs. Dr. Beeson, Forest Entomologist, Forest Research Institute, Dehra Dun, recorded a number of food-plants for *Lyctus africanus*, and in response to his request this investigation was taken up by the author with a view to finding out the extent to which the recorded food-plants are subject to attack by *Lyctus* beetles.

Material and method of study.—Since no record was available as to the exact size of *Lyctus africanus* eggs, an attempt was made to obtain some eggs for the purpose of measuring their diameters. With this object in view, the following experiment was carried out :—

Small cubes (say $\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{3}{4}''$) of timber (sapwood) with fairly large vessels were prepared and clamped together. These were then placed in bottles along with some live beetles of *Lyctus africanus*. The main idea underlying this procedure was to find out whether the beetles can lay eggs in the wood as well as in the joint in between two blocks of wood. Eggs were found inside the wood blocks but not in the joints between blocks. Thus it was possible to record the diameters of 10 eggs. The maximum diameter at the widest part of the egg was found to be 130 microns, while at the narrowest part it was 108 microns. The maximum diameter in the case of almost all eggs was found to be 130 microns.

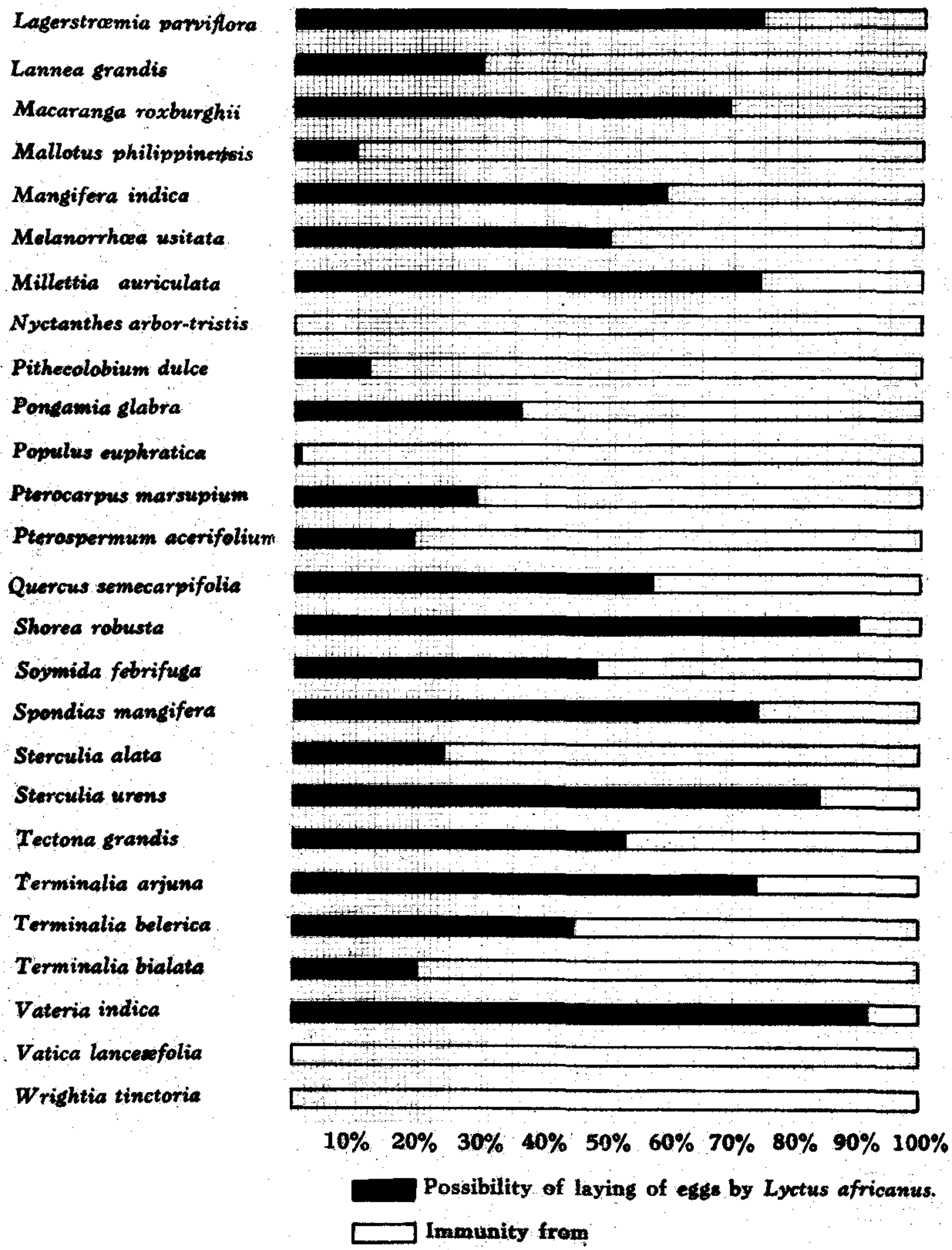
The wood samples studied were from the collection of the Forest Research Institute, Dehra Dun, which is usually obtained from different parts of India. A list of the timber species studied showing the localities from which they were collected is given at the end of this paper. The samples studied included one bamboo, five ring-porous or semi-ring-porous woods and the rest were diffuse-porous woods. In all 52 species were studied. Examination of a species was mostly confined to one slide. Only in a few cases more than one slide was examined in order to record the diameters of at least 100 vessels. The total number of measurements taken was 12,544, and on an average 121 vessels were measured for a species.

With the help of a "Metron Reflex Drawing Outfit," both tangential and radial diameters of vessels were measured directly in microns, and recorded separately. Then these diameters were plotted in a graph; the horizontal axis representing the radial diameter, and the vertical axis the tangential diameter. Since the maximum diameter of the egg was found to be 130 microns, two lines, one horizontally and the other vertically, were drawn separating the vessels less than 130 and those more than 130 microns (Graph I). The vessels on the right hand side of the vertical line and below the horizontal line were more than 130 microns both tangentially and radially and were thus the possible egg-laying places for the *Lyctus*. The total number of vessels recorded was worked out and also the number of vessels which have both diameters more than 130 microns. From these two, the percentage of vessels with more than 130 microns in diameter was calculated and this at the same time gave the percentage of possible egg-laying places for *Lyctus* in a timber species.

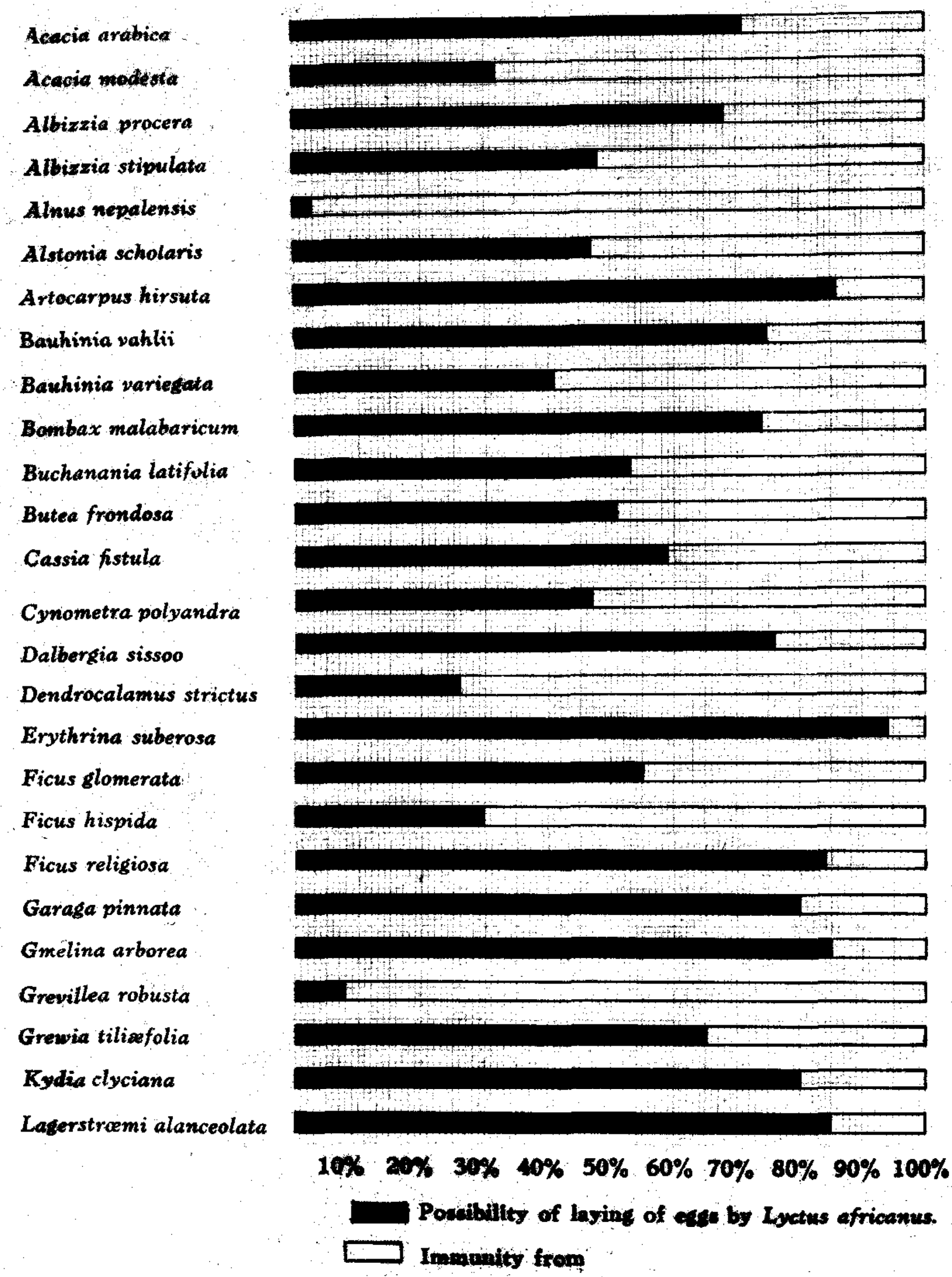


In the same way all the species have been worked out and the final results are shown in terms of the percentage of possibility of, and immunity from, laying of eggs by *Lyctus africanus*. Dr. Beeson pointed out in his original note that a few species were wrongly recorded as food-plants in the list. On examination it was found that 3 species, namely *Nyctanthes arbor-tristis*, *Vatica lanceæfolia* and

Possibility of *Lyctus* attack depending on vessel size.



Possibility of *Lyctus* attack depending on vessel size.



Wrightia tinctoria, were not likely to be attacked by *Lyctus africanus*, since their maximum vessel size was smaller than the size of *Lyctus* eggs (Plate XIV).

Discussion.—While recording the diameters of vessels it was noticed that although a general correlation seems to exist between tangential and radial diameters, yet some vessels had one diameter out of proportion to the other. After plotting, a distinct correlation was found between the two diameters but again a few cases of irregularities were observed. In the circumstances it was thought advisable to take into consideration two diameters separately instead of taking the average of both, for the tangential and the radial diameters of the egg were 130 microns in each case and no egg could be laid in a vessel whose one diameter was less than 130 microns,—no matter how large the other diameter may be. Eggs can be laid only in those vessels in which both tangential and radial diameters are more than 130 microns.

The vessel size of different species belonging to a genus showed such a marked difference (Figs. XIII and XIV) that it was not possible to lump together the species under a genus. This discrepancy in the vessel size of different species can be understood, when we take into consideration the vast difference in the climatic condition and the localities in which the various species grow in India.

It will be noticed that one bamboo has been included in the list. Due to somewhat irregular distribution of vascular bundles in it, it was not possible to ascertain true tangential and radial diameters of its vessels. The widest part of the vessel in the cross section was measured and recorded as radial, while the tangential was measured at right angles to the radial. The same procedure was also followed in some broad-leaved species in which the vessel distribution was very irregular.

Summary.—(1) A distinct correlation was found between tangential and radial diameters of vessels in the species studied with a few exceptions.

(2) *Lyctus* can lay eggs only in those vessels whose tangential and radial diameters are each larger than the diameter of the eggs.

(3) Different timber species belonging to a genus show a marked difference in their vessel size.

In conclusion, I wish to express my grateful acknowledgment to Mr. A. D. Blaschek, President, Forest Research Institute, for kindly drawing my attention to certain recent publications in connection with this investigation. My thanks are also due to Dr. C. F. C. Beeson, Forest Entomologist, and Mr. J. C. M. Gardner, Systematic Entomologist, for some helpful information and suggestions and to Mr. S. Ghosh of the Wood Technology Section for his assistance during this investigation.

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LIST OF SPECIES EXAMINED, WITH LOCALITIES FROM WHICH THEY WERE COLLECTED.

Acacia arabica (U. P.).

Acacia modesta (Jhelum, Punjab).

Albizzia procera (Saharanpur, U. P.).

Albizzia stipulata (Dehra Dun, U. P.).

Alnus nepalensis (Kumaon, U. P.).

Alstonia scholaris (Garo Hills, Assam).

Artocarpus hirsuta (Coorg).

Bauhinia vahlii (Darjeeling, Bengal).

Bauhinia variegata (Dehra Dun, U. P.).

Bombax malabaricum (Burma).

Buchanania latifolia (Raipur, C. P.).

Butea frondosa (Dehra Dun, U. P.).

Cassia fistula (Gonda, U. P.).

Cynometra polyandra (Garo Hills, Assam).

Dalbergia sissoo (U. P.).

Erythrina suberosa (Dehra Dun, U. P.).

Ficus hispida (Burma).

Ficus glomerata (Dehra Dun, U. P.).

Ficus religiosa (Dehra Dun, U. P.).

Garuga pinnata (Raipur, C. P.).

Gmelina arborea (Chanda, C. P.).

Grevillea robusta (Saharanpur and Dehra Dun, U. P.).

Grewia tiliæfolia (Kanara, Madras).

Kydia calycina (Dehra Dun, U. P.).

Lagerstrœmia lanceolata (Kanara, Madras).

Lagerstrœmia parviflora (Kurseong, Bengal).

Lannea grandis (Terai, Bengal).

Macaranga roxburghii (tomentosa) (Travancore).

Mallotus philippinensis (Dehra Dun, U. P.).

Mangifera indica (Buxa, Bengal).

Melanorrhœa usitata (Burma).

Millettia auriculata (U. P.),

Nyctanthes arbor-tristis (C. P.).

Pithecolobium dulce (Madras).

Pongamia glabra (Dehra Dun, U. P.).

Populus euphratica (Sukkur, Sind).

Pterocarpus marsupium (U. P.).

Pterospermum acerifolium (Burma).

Quercus semicarpifolia (Chakrata, U. P.).

Shorea robusta (Bahraich, U. P.).

Soymida febrifuga (Panch Mahal, C. P.).

Spondias mangifera (Dehra Dun, U. P.).

Sterculia alata (Dehra Dun, U. P.).

Sterculia urens (Berhampur, C. P.).

Tectona grandis (Coimbatore, Madras).

Terminalia arjuna (Khandesh, Bombay).

Terminalia belerica (Dehra Dun, U. P.).

Terminalia bialata (Andamans).

Vateria indica (Kahara, Madras).

Vatica lanceæfolia (Cachar, Assam).

Wrightia tinctoria (Kolaba, Bombay).

Dendrocalamus strictus (Hyderabad, Deccan).

THE CONGRESS OF THE INTERNATIONAL UNION OF FOREST RESEARCH ORGANISATIONS.

BY C. F. C. BEESON, I.F.S.

The Congress of the International Union of Forest Research Organisations was held in 1932 in France and assembled on the 4th November at the National School of Forestry, Nancy. It was well attended; twenty-eight out of the thirty-five countries forming the union sent official delegates. In addition to the numerous members of forestry organisations in Europe there were also representatives from Australia, Canada, Cyprus, Japan, Nicaragua, Nigeria, Palestine, Uganda and the United States. The forest departments in India sent three delegates.

The business conducted by the International Committee and the several sections of the Congress was varied and much more practical than is usually to be expected of World Congresses.

One of the most important questions on which a decision was reached concerns the preparation of a bibliography of forestry literature. The scheme adopted by the special commission proposes that each country should nominate an institution to prepare and classify references to articles, periodicals, books, etc., published in that country and to distribute copies of these references periodically to each of the

participating countries in exchange for its own references. Each country (or possibly group of countries using the same language) should then publish the collected references in its national language and in a form most convenient for its own use.

The question of standardising the description of forest crops and the methods of forestry research reached the stage at which it was possible to appoint a small committee to make a precis and comparison of all the reports sent in by the collaborating countries.

Schemes for the standardisation and unification of research in resin-production, timber-testing, root-competition, nomenclature of soils, description of sample plots, etc., were formulated on similar lines.

The only section in which no progress was made was that of forest protection as arrangements to hold meetings of the forest entomologists in connection with the fifth International Congress of Entomology in Paris in July 1932 fell through.

Very well organised visits to various forest regions in France took place before and after the session of the Congress, and pleasant excursions in the neighbourhood of Nancy were arranged during Congress week.

The International Union of Forest Research Organisations made a successful beginning at Stockholm in 1929, and the Nancy meeting shows that it has lost none of its vitality or promise of becoming a most productive organisation. Fortunately it possesses the three conditions indispensable to any protracted undertaking—co-ordination of effort, continuity, and method. The Union has a Permanent Committee whose function is to ensure that effect is given to the decisions and resolutions of the Congress in the interval between two meetings and to organise the comparison and dissemination of results obtained.

The next Congress will be held in Budapest in 1936.

FOREST SOILS.

By E. A. Garland, I. F. S.

Rather more than a decade ago the question, " what is the first duty of a forest officer ?" was set in a final examination of probationers

for the Imperial Forest Service. One candidate answered "to keep his bowels open," and is alleged to have been given full marks. The correct answer however was "to maintain and improve the productive capacity of the soil." Everyone will probably agree with this principle, since even the greatest skill and labour in raising a crop cannot bring it to yield fully without the necessary soil fertility. To widen the basis of this rule it might be equally true to say that it is the first duty of a Forest Service to study its soils. Government Agricultural departments, University research workers, and lately the research departments of large commercial chemical firms in all parts of the world have made extensive studies and published an enormous volume of literature concerning the conditions of the soil affecting the growth of field crops. But forest crops, which also play an important and possibly vital part in the economic complex of the whole world, seem to have been strangely neglected in this respect. This neglect is particularly striking when consideration is given to the fact that almost all agricultural soils must once in time past have been forest soils over a large part of the world, and that therefore their characteristic features must be dependent to some extent on the type of forest crop which they once carried. The study of forest soils as they exist to-day would therefore not only be of immense value to foresters but might also hold the key to the solution of many of the problems which still baffle scientific students of agriculture.

Science has discovered many of the ways in which Nature works, and can imitate her to a certain extent. We know that soil fertility is dependent on what we call soil organic matter, or more shortly "humus." It has been shown, by Falck, Waksman and others, that this soil organic matter is a heterogeneous mass of substances which is constantly undergoing changes in composition. In fact a chemical action is perpetually occurring, of which the main features are the addition to the soil of organic material in various "dead" forms and the synthesis of these materials by the soil population into different forms, from which "living" vegetation is capable of developing. In forests undisturbed by man Nature carries out the process in her own manner, slowly increasing the fertility of the soil so that the vegetation,

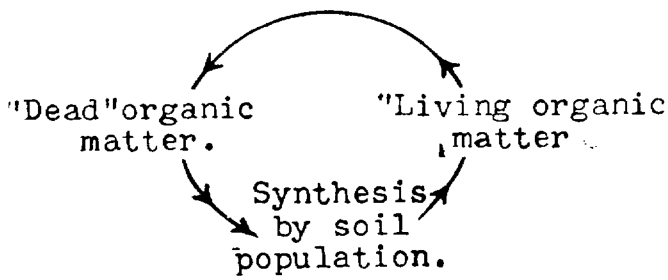
which it develops, gradually changes. Any drastic removal of this crop interferes with the process, so that under the new conditions thus created a different vegetation may result at first, but eventually substantially the same original conditions will again develop and the original vegetation will again appear. Hence the science of Plant Ecology, for the study of the normal progression of vegetation and the way in which it reacts to various interferences, is in reality the study of a so-called " end-product " of the chemical action taking place in uncultivated soil. The agricultural soil scientists have already discovered that the most important and intricate part in the process of development of soil fertility lies in the behaviour of the soil population of micro-organisms, bacteria, fungæ, actinomycetes, algæ, protozoa and nematodes. Only relatively little detailed knowledge has so far been obtained about them, many still being unidentifiable with any certainty. It appears that most of the work so far carried out has been done on their occurrence and reactions in cultivated soil. There is still immense scope for their study in their natural habitat, virgin forest soil.

In cultivated soils, the natural processes whereby soil fertility is recruited are largely broken up by the substitution of a different vegetation and by the perpetual removal of a larger part of the crop. Long experience has gradually taught cultivators various methods by which the fertility of the soil can be maintained. But the reason for this was very imperfectly understood. The advance in knowledge of cultivated soil in recent years has been great. As Sir E. J. Russell points out in his preface to the 6th edition of his important work *Soil Conditions and Plant Growth*, it was possible in 1912 to summarise adequately all that was then known in a small volume of 168 pages, whereas the present edition contains over 600 pages and has been kept to that limit only by repeated and prolonged examination of the available material. This knowledge having been chiefly obtained under conditions in which labour was scarce but money was plentiful, and the earlier scientific results being chiefly concerned with the requirements of crops for nitrogen and various minerals, the manufacture and sale of " artificial manures " added considerably to the fertility of soils,

in which the other requisites were maintained by tillage and the addition of organic matter, either by the application of farmyard manure or by herding sheep. The population of the world has recently however begun to realise that while science can manufacture many artificial substitutes for Nature's products, these are frequently uneconomic. Indeed at the present time very few forms of artificial production seem to be truly economic and this breakdown of the economic scheme, as formerly visualised, has even affected agriculture, the primary source of man's existence, upon which all his civilisation has been built. Scientific knowledge of the true causes of soil fertility has however already shown the way by which these difficulties may be overcome. Pioneer work was carried out at the Rothamstead Experimental Station and it is now well-known to chemists that valuable manures can be prepared from almost any kind of vegetable " waste." The procedure has already been fully developed at Rothamstead in a manure made under a patented process and known as Adco, and in a form adapted to Indian conditions the same principles are put into practice at the Institute of Plant Industry at Indore. This latter work has been fully described by A. Howard in *The Waste Products of Agriculture*, Oxford University Press, 1931. If the fertility of cultivated soil can be maintained and even improved, by the addition only of such organic matter as can be produced naturally year by year in any forest, relatively little further research, properly applied should enable us so to adjust our forest management that much greater certainty in the replacement of exploited crops, and a higher yield from the existing crops, would be obtained.

The whole object of scientific soil management, whether it be in field or forest, is to produce the maximum amount of vegetation, with the proviso that as large a part as possible of this vegetation should be useful to man. In field crops the principal products required are the seeds, roots or leaves; in forest crops, the stems. Experience has gradually taught mankind that certain crops grow best under particular conditions of soil and climate, and the scientists are gradually beginning to understand more and more why certain crops fail. But what we appear always to have lacked has been any definite " yard-

stick," against which to measure the comparative success or failure of our methods of management to raise the soil to the absolute maximum state of fertility. Fertility has always appeared to be an infinite state which could be increased more or less indefinitely, with the immediate corollary of an increase in production of vegetation. Yet all the time this " yardstick " lies ready to our hand, in what the Ecologists term " climatic climax vegetation." There the wheel of life must be in that perfect equilibrium which is only possible when each section completely fulfills its part.



Any alteration of the climax vegetation produced in Nature must react on the other parts of the wheel and disorganise the exact adjustment of the processes which go on in the soil. The task of all soil scientists, to assess the changes thus initiated, would be immensely facilitated by being able to compare each stage with an unchanged ideal state. Possibly there is no such thing as a true climatic climax in existence anywhere in the world to-day : it may even never have existed. But in our natural forests we do possess an approach to this ideal. The provision of " Reserves " by Governments, to be kept as far as possible untouched by man, except for scientific observation, should be regarded not as affording a harmless playground for amiable but rather ineffective gentlemen who describe themselves as,——————————something ending in——ist, but as the most essential laboratories, containing in their soil the still hidden secret of true economy. The provision of every facility for the wisest of their scientists to search out this secret is a corollary which should need no emphasis.

EXTRACTS.

OLD AND NEW TREES.

[According to a recent statement in the Press, the yews at Fortingall, in Perthshire, estimated at from 2,500 to 3,000 years old, are the most ancient trees in the British Isles.]

Some folk see trees as timber—
Potential pulp or pelf;
Some as the home of limber
Dryad and faun and elf;
And some adore Ju-Ju trees
Or bottled anti-flu trees,
The eucalyptus (blue) trees
Upon the chemist's shelf.

Blacksmiths, the poet teaches,
A "*spreading chestnut*" *seek*,
And burnished copper beeches
Appeal to cop and beak;
Some think we have too few trees,
And some delight to hew trees,
While gardeners love their fruit-trees
As Welshmen love the leek.

Though pressmen, ever prying,
Tell us of monstrous boles
At Fortingall, defying
The rule of girth controls,
More than funereal yew-trees,
Punch loves the little new trees,
Especially the boot-trees
That ease our suffering soles.

C. L. G.
(*Punch, 7th December* 1932).

FOREST AND STREAM FLOW.

The effect of the action of forests in conserving water supplies and regulating the flow of water in streams and rivers, whilst preventing erosion in mountainous countries with consequent disastrous floods, has been under discussion for several centuries. Attention was directed to this important matter in an article entitled "Forests, Climate, Erosion, and Denudations" in *Nature* of April 4, 1931. The opinions commonly accepted by foresters and many engineers are to the effect that forests are beneficial (1) by retaining and storing water in the humus layer on the

forest floor and allowing it to percolate gradually into springs and streams, thus retarding a rapid run-off; (2) retarding the melting of snow in the spring and thus prolonging the run-off from this source; (3) increasing precipitation; (4) preventing erosion on steep slopes. It may be admitted that direct proof of the actual effect of disafforestation of the catchment area of a river on the future water level of that river based on a prolonged series of measurements, has been so far wanting. But the ultimate results, both to the catchment area and the plains country below should reafforestation not take place, cannot be called in question. Europe itself, along the shores of the Mediterranean, and many parts of India offer numerous illustrations of the aftermath of reckless forest denudation, followed by the drying up of water supplies.

In a paper entitled "Forests and Stream Flow" delivered before the American Society of Civil Engineers at its annual convention in Yellowstone Park on July 6, 1932, Messrs. W. G. Hoyt and H. C. Troxall call in question, from the engineers point of view, the usefulness of forests in maintaining and regulating water supplies. They base their conclusions on the following. An experiment by the United States Forest Service and the U. S. Weather Bureau was conducted from 1910 until 1926 on two contiguous tracts of land in Southern Colorado (Wagonwheel Gap area) of 222·5 and 200·4 acres respectively, having almost identical geographical, topographical and meteorological conditions. The forest cover in both areas was representative of the Rocky Mountain area as a whole. In 1919 the smaller area was disafforested and the slash burnt in 1921. By 1926 the area had become recovered by a growth of grass, herbs and aspen shoots which had reached a height of three to six feet. Throughout the period, accurate measurements of the run-off and meteorological observations were recorded.

A distinct investigation on stream-flow measurements was begun in 1916 under the auspices of the U. S. Geological Survey, in co-operation with the State of California and the County of Los Angeles on certain areas in California. In August 1924 a forest fire burnt some of the areas under observation, and one of them, Fish Creek, was selected to establish the effect of the fire and resulting disafforestation on the discharge of this creek. A new growth appeared over the area burnt, and by the autumn of 1930 it is said that little evidence of the fire remained, though a different plant association had developed.

The investigations recorded by the authors, and the deductions therefrom, are therefore based in the first case on the observations of seven years (1920—1926) and in the second on six years (1925—1930). It is impossible to do more than glance at the conclusions arrived at from the records and data, which are most ably dealt with in this monograph. They are, however, sufficiently startling to require more detailed investigations on the same lines and will merit careful consideration in many parts of the British Empire where forests, agriculture and commercial interests are so inextricably interwoven. Briefly, the authors hold that forests do not conserve the water supply; that the increase of run-off is not confined wholly to flood periods; that after disafforestation in the Wagonwheel area there was an increase of forty-six per cent

in maximum daily discharge; that the belief that forests or vegetation covering will increase the summer run-off and shorten the low-level period through the exercise of storage functions is a fallacy, so far as the records on the two above widely differing areas are concerned. Further, that coincident with the increase in the summer run-off there was an increase in the average summer minimum and the period of low water run-off was considerably shortened; disafforestation made no appreciable change in the low flows which occurred during the winter in the Wagonwheel area.

The authors, who are hydraulic engineers, state that they are lovers of the forest, but in the interest of water supplies and the maintenance of water supply levels, they consider that " If the small growth that springs up immediately after disafforestation " (though this is not the case in all countries) " or denudation exercise practically the same effect as forests in reducing normal flood crests and in preventing erosion without the detrimental effect which forest cover is shown to have on annual flow and flow during the summer low-water periods—then in basins where shortages in water supply are becoming critical or where abnormal expenditures have to be made to augment water supplies, the maintenance of forests or reafforestation for the ' conservation of water supply ' may have an effect exactly opposite to that desired."

The investigations, which have been carried out in so liberal a spirit by the United States, are of the greatest importance; and they certainly put a question mark to assumptions which have long been held. It is, however, difficult to believe that foresters and many others who have studied this matter will be able to accept all the deductions of the authors when they are based on records of so short a period as six to seven years.

(*Nature*, *10th December* 1932.)

PLANT PATHOLOGY IN THE FORESTS OF INDIA.

PART I.—BY R. S. HOLE.

1. In the *Indian Forester*, Vol. 25, November, 1899, p. 431, Mr. J. S. Gamble published an article *On the determination of the Fungi which attack Forest Trees in India* in which he pointed out how little progress had been made with this subject and urged Forest Officers in India to collect specimens of fungi and send them in for identification. Again, in the *Indian Forester*, Vol. 31, February, 1905, p. 85, Mr. Gamble wrote as follows: " Of course! botany is well taught at Coopers Hill; whether it has always been quite the sort of botany that is wanted for our purposes is another matter, but as the college is so soon to cease to exist, it is not now worth while further to discuss the subject. I might, however, make the remark that, although Professor Marshall Ward is one of the highest authorities on the fungoid diseases of trees and must have taught about them to some extent, but one of his old pupils, so far as I know, has yet attempted to pursue

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APRIL, 1933.

THE IMPORTANCE OF THE ORIGIN OF SEED USED IN FORESTRY.

As an outcome of a resolution passed by the 1929 Silvicultural Conference at Dehra Dun, Mr. H. G. Champion has recently produced Indian Forest Record, Vol. XVII, Part V, bearing the above title, and we welcome its appearance, both because it shows that our Indian silviculture is being developed on soundly progressive and scientific lines, and at the same time it serves to bring the average forest officer in India into close touch with the latest developments in European research. From the latter point of view we can recommend this Record to all our readers for very careful study, for it summarises in a masterly fashion the conclusions of some 150 publications, most of which are for very obvious reasons beyond the reach of the man in the jungle.

The main conclusion drawn from all this research is intensely practical. It is that we must pay more attention to the collection and harvesting of tree seed, using every possible precaution to ensure that our future crops are raised from the progeny of only the best mother trees. The accumulated evidence in many lines of breeding experiments apart from those actually done with forest trees all goes to prove the benefits of a good heredity. Recent advances in modern farming whether with fruit trees, cereals, sugar-cane, rubber, or cotton have been along the lines of improved production by intensive breeding and by fighting disease through developing disease-resistant strains. The losses incurred by the use of unsuitable seed have been very large in the case of annual crops such as cereals, but the mischief must obviously be magnified when similar mistakes are applied to tree crops which take a century or more to ripen.

No farmer would think of planting an orchard with wild plums or apples or a field with inferior seed of wheat or cane when he can obtain highly productive stock which he knows will give him a heavy yield of a valuable crop. Why then should the forester be content to raise his plantations from seed collected at random from " any old tree " ? . If rapid growth is to be our aim, then let us concentrate upon attaining that end by careful seed collection from only the finest trees, discarding undersized seed and again discarding undersized plants at each stage of nursery handling. If our aim is to produce a form resistant to some pest or disease which is proving a local menace, we are again forced to tackle the problem along the lines *indicated in Champion's pamphlet if we are to find a solution.* The hereditary character of spiral grain has been clearly proved in the case of *Pinus longifolia*, and although admittedly adverse conditions such as fire and grazing during the growth of the young tree do exaggerate the condition, the most obvious line of attack, if we are to improve our *chir* crops, is to use seed collected from straight-grained trees. The occurrence of *gauj* in *sal* is possibly a parallel problem, and with the more extensive practice of *taungya* for raising young *sal* crops we have a better opportunity than heretofore for improving our forest stock by using only selected seed from a known source.

If on the other hand our aim is to grow timber for special markets, such as a figured wood which may fetch four or five times the price of the normal timber, or mulberry carrying a large amount of sapwood for the special needs of the sports manufacturers, or sandal with wood of a heavy oil content, the problem is not quite so straightforward, but a critical analysis should show how far we would be justified in spending time and money on developing some local hereditary strain which would answer our special requirements. Amongst the figured timbers it appears that figured *sain* (*Terminalia tomentosa*) is much commoner in some of the local races of Assam than it is elsewhere, while in the case of *Chukrasia tabularis* it is from Burma that most of the figured logs come, though the tree is common enough elsewhere. The occurrence of flowered teak timber is more widely met with and apparently more erratic, but in all these cases some

further intensive work on the heredity of these valuable " freaks " is badly needed and money spent on this work might eventually give very large cash returns.

Foresters are apt to be pessimistic about such improvements, for through being in constant association with century-old trees, they naturally become impressed with the difficulty of influencing the character of long-lived forest trees by any of the remedies practised by farmers or fruit growers. The forester's is undoubtedly a more difficult problem but there is every reason to hope that great improvements can be effected by applying the methods already employed so successfully in improving other crops. Following the example of Luther Burbank who brought about the most amazing improvements in the culture of walnuts and plums, the Institute of Forest Eugenics in California (formerly the Eddy Tree Breeding Station) is working on the American pines. By selection from the fastest growing individuals and the best geographical races and by regulating the cross-pollination to secure hybrid vigour in pine trees they have already had some success and we understand that Mr. Lloyd Austin is shortly to publish more of these results. The cross-pollination is carried out by painting pollen onto female flowers which have been protected by grease-paper bags, and for this purpose pollen of ***Pinus longifolia*** and *P. excelsa* was sent from India, though we have not heard that any hybrid seed or stock has resulted. Less spectacular but much more practical results are being obtained from the wide selection of the best individual nursery trees from many forest nurseries scattered throughout the United States. These are brought to the Institute's arboretum at Placerville and planted out there.

Nearer home we have the South African work on wattles by J. B. Osborne (*Emp. For. Jour.*, December 1931). With such a quick growing crop as *Acacia mollissima* he has already effected a remarkable improvement in the rate of growth and in the bark yield and tannin content by mass selection of seed from marked individual mother trees. In Britain the chance hybridisation of the European and Japanese larch has produced the " Dunkeld hybrid " which is al

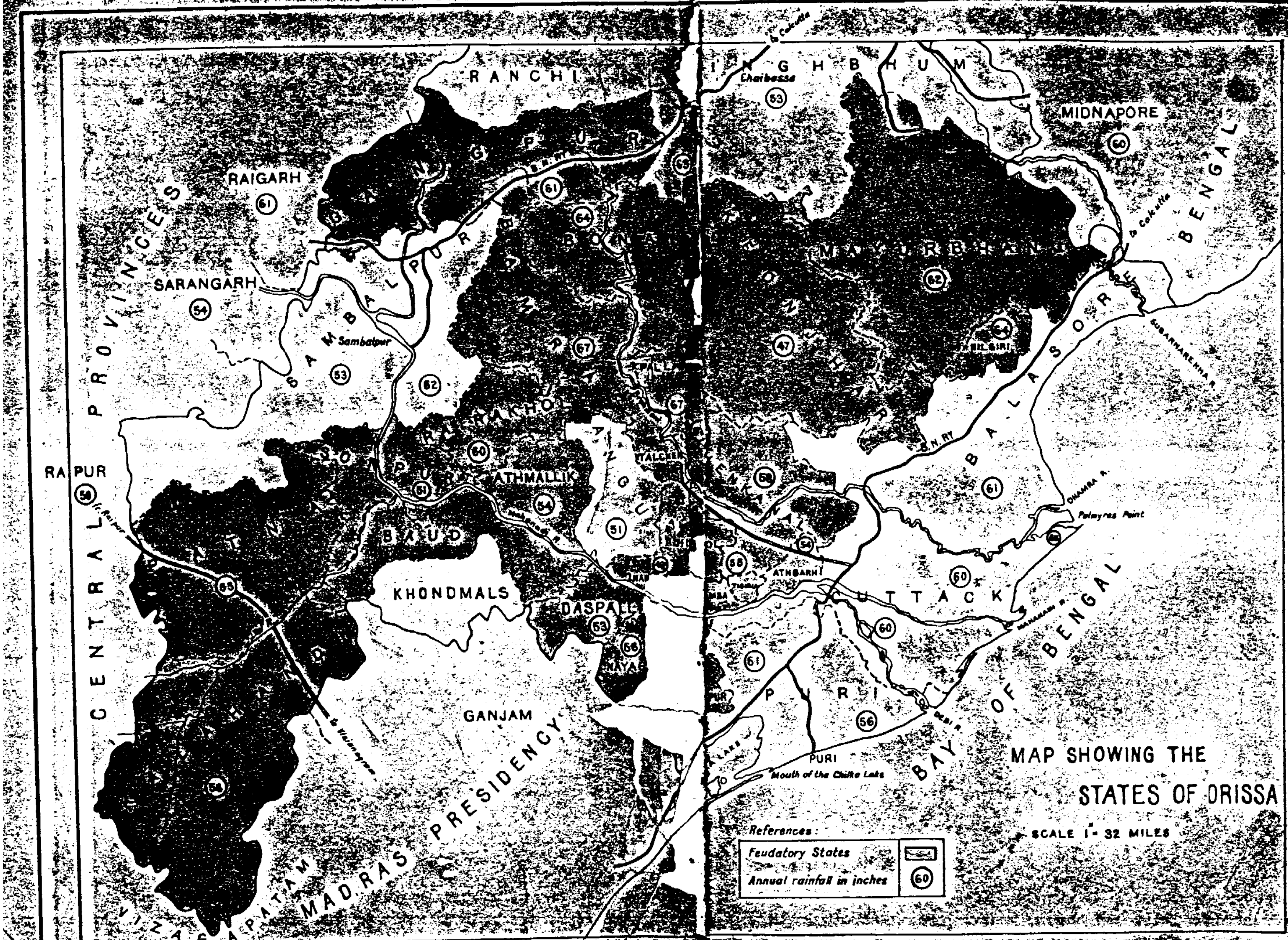
in its third generation and whose progeny has so far proved immune to the dreaded larch canker disease. In a preliminary account of his work on the races of European larch in the *Scot. For. Jour.* of March 1932, Dr. M. L. Anderson says " The work of isolating and growing special races of trees is of as great importance in silviculture as is similar work in agriculture and horticulture. The perennial nature and high reproductive capacity of the individual enhances the value of such work for forestry ". But we have got a lot of leeway to make up.

THE FORESTS OF THE ORISSA STATES.

BY H. F. MOONEY, I. F. S.

A paper was read on the above subject at the Bihar and Orissa Forest Conference held in 1930. It has been expanded into the following article in the belief that it may be of general interest. Although individually some of these States are of very small extent, collectively they form a substantial part of the Province and, from a forest point of view, assume an additional importance in consequence of the limited area of Government reserves.

The States, numbering twenty-six, vary in size from 46 to 4,243 square miles and constitute, together with the five British districts of Balasore, Cuttack, Puri, Angul and Sambalpur, the sub-province of Orissa. They cover an area of 28,664 square miles, forming an extensive and generally undeveloped tract of country, a very considerable proportion of which is covered in forest. The area is little known and parts of it, especially in the south-west on the borders of Madras and the Central Provinces, are remote and inaccessible. It forms part of what was until quite recently the largest tract of country in India untapped by a railway, if portions of the Central Provinces and Madras be included. This position has, however, been altered by the completion of the Raipur-Vizianagram line, which passes from the Central Provinces through the west of the area and traverses Patna and Kalahandi States. This group of States is under the control of a Political Agent, who is assisted by certain technical advisers, including an officer of the Indian Forest Service.



MAP SHOWING THE STATES OF ORISSA

Physiography.—The tract may conveniently be divided into three main topographical divisions, *viz.* (1) the northern extremity of the Eastern Ghats, which are interrupted by, (2) the basin of the Mahanadi and are thus separated from, (3) the broken mountainous country lying to the south of and including the southern scarps of the Chota Nagpur plateau. The west of the area consists of an extensive plain lying chiefly between the Mahanadi and its large southern tributary the Tel, and includes the whole of Sonpur and Patna States, together with parts of Sambalpur district and north Kalahandi. After the confluence of these two rivers the valley of the Mahanadi narrows somewhat before entering the deep gorge, seventeen miles in length, which is situated some seventy miles above the town of Cuttack, where the delta commences. The valley is bordered at a distance of a few miles (except in the gorge where the hills descend steeply to the water's edge) on either side by a fairly continuous chain of high hills, which exceed 3,000 feet in places. To the south, towards the Madras border, some high plateaux exist attaining 4,000 feet in Kalahandi State. North of the Mahanadi the country assumes an extremely rugged nature, steep ridges and narrow valleys being characteristic features of the landscape. A few peaks in Mayurbhanj, Keonjhar, Bonai and Pal Lahara States exceed 3,500 feet. This type of scenery continues until the southern scarps of the Ranchi plateau are encountered.

Besides the Mahanadi and the Tel, which rise in the Central Provinces and flow east through Orissa, other rivers of importance are the Brahmani, Baiturani and Barabulang, all flowing from north-west to south-east from the Ranchi plateau and the Simlipal Hills of Mayurbhanj into the districts of Cuttack and Balasore. The only other river of importance within our area is the Indravati, which has its source on the Kasipur plateau in the south of Kalahandi State and flows west to form the boundary between the Central Provinces and the Madras Presidency for some distance.

Climate.—The climate is of the usual monsoon type, most of the rainfall being derived from the Bay of Bengal current, only a small area in the west being also affected by the Arabian sea current.

The rainfall over the greater part of the tract exceeds 60 inches and falls chiefly during the four months, June to September. The precipitation in the Simlipal Hills of Mayurbhanj and on the high plateau in the south of Kalahandi must be considerably in excess of this; in fact, a few records of over 100 inches have been made in the latter locality. Generally speaking, however, there are no recording stations in the more hilly and remote parts, where the rainfall is likely to be greatest. From the accompanying map it will be seen that a strip of country running through the centre of Orissa possesses a rainfall with an average of about 56 inches, the lowest records (slightly under 50 inches) being from the towns of Angul and Keonjhar, but these are not representative of the surrounding country. The average number of rainy days, when the rainfall exceeds 0·1 inch, is about 74.

The mean minimum temperature is over 70° F. and the mean maximum about 90° F. The cold season is very short and mild, frost being practically unknown except in the mountains of Mayurbhanj, Keonjhar, Bonai and south Kalahandi. In addition to high temperatures and a moderately heavy rainfall, the humidity in those States of the Agency near the coast is also high, notably during the period October to March.

Geology.—Most of the rocks found in Orissa are of very ancient origin. Bengal gneiss, often dioritic, covers large areas and is associated with schists of various composition and an abundance of accessory minerals. Among these *khondalite* (*sillimanite-gneiss* and *sillimanite-schist*) may be mentioned owing to its frequency in the hills bordering and to the south of the Mahanadi as it often carries good crops of *sal.* The mountains in the north of the States of Mayurbhanj, Keonjhar, Bonai and Gangpur consist largely of rocks of the Dharwar system, *quartz* and *mica-schists*, *shales*, *phyllites* and *quartzite* being among the chief constituents, frequently containing rich deposits of iron in the form of *haematite*, and also more rarely manganese. These Dharwar rocks all show an intense degree of metamorphism.

The Lower Gondwana system is represented by the Talcher series in Rairakhol, south Bamra and Talcher States. It comprises

sandstones, conglomerates, shales and coal measures, with a boulder bed clearly indicative of glacial conditions. The Athgarh sandstone, taking its name from Athgarh State, belongs to the upper Gondwana system (corresponding with Jurassic) and occupies a small portion of the south-east of our area close to the head of the Mahanadi delta.

Laterite is frequently encountered, generally capping the high hills and plateaux. It also occupies certain areas at low elevations chiefly towards the coast in the States of Nilgiri, Dhenkanal, Athgarh and Nayagarh, where it is associated with and overlies the Athgarh sandstone. Calcareous concretions (*kankar*) may also be mentioned owing to their frequent occurrence in eroded ravine lands. Black-cotton soil is widespread, particularly in the west of the Agency in Sonpur, Patna and Kalahandi States.

Population.—The Orissa Agency is very largely populated by aboriginal tribes, among whom the Khonds in the south, the Bhuinyas in the north and the Santals in Mayurbhanj State are the most numerous. The more fertile low lands, such as the Mahanadi valley and the rich plains of Sonpur, Patna and Kalahandi are for the most part inhabited by the Aryan Oreyas. The hilly and more remote jungle tracts are the strongholds of the aborigines, where they still continue to raise crops by the wasteful and destructive process of *dahi* or shifting cultivation. The two main centres of this practice are the Bhuinya Hills of Keonjhar, Pal Lahara and a part of Bamra, which is the home of the Bhuinyas and Juangs ; and the high plateau and hilly country in the south-east and south of Kalahandi, where the Khonds are still undisputed masters. Other tribes, such as the Mundas, Hos, Uraons and Kharrias are confined to the north and north-west of the Agency, mainly in Bonai, Bamra, Gangpur and Seraikela States.

Some of these tribes are still very primitive. It may be mentioned in passing that the Juangs have only recently abandoned the custom of wearing leaves ; while it is not so very long since the practice of the *meriah* sacrifices was still prevalent among the Khonds, a human victim being sacrificed in order to ensure a good harvest.

The Forests.—The total area of permanently demarcated forest amounts to about 6,739 square miles, consisting of 6,351 square miles of reserved and 388 square miles of protected forest. This constitutes just under 24 per cent. of the gross area of the states and compares favourably with that of the Government forests, which cover only 3·7 per cent. of the British districts of the Province, being composed of 1,838 square miles of reserved and 1,177 square miles of protected forest. The following brief sketch of the forest flora gives only a general idea of the salient types with a short reference to the dominant plant associations.

Except for a limited area in the south-east near the coast, the forests belong to the dry deciduous type. *Sal* is the chief species and occurs throughout the whole area wherever the climatic and edaphic conditions are suitable. It varies considerably, as one would expect, from magnificent stands of I quality to miserable open crops of stunted trees on clay and lime soils. Two main classes of *sal* forest may be distinguished, which differ rather materially from one another in their composition. They are (*a*) the dry type, and (*b*) the damp type.

(*a*) *The dry type* is more widespread and more representative of the area as a whole, resembling closely the *sal* forests of Chota Nagpur and the Central Provinces in respect of its associates. The *sal* may and often does, form 80 per cent. of the crop or even more, the following being the more important species found in association with it:—*Terminalia tomentosa, T. chebula, T. belerica, Bassia latifolia, Pterocarpus marsupium, Schleichera trijuga, Buchanania latifolia, Bridelia retusa, Garuga pinnata, Diospyros melanoxylon, Ougeinia dalbergioides, Careya arborea, Emblica officinalis, Bursera serrata, Lannea grandis, Dalbergia latifolia* (rare), *Gmelina arborea* (scarce), *Stereospermum suaveolens, Anogeissus latifolia,* and others. *Eugenia jambolana, Terminalia arjuna* and *Diospyros embryopteris* occur in this type of forest, the first named often and the latter two invariably near streams. *Dendrocalamus strictus* seldom occurs together with *sal*, but it is occasionally found in association with it on *quartz* and

mica-schists on very dry hillsides. On these schists the *sal* is usually of poor growth and is associated with *Wendlandia exserta*, *Gardenia gummifera* and grasses such as *Heteropogon contortus* and *Aristida* spp.

(*b*) *The damp type* of *sal* forest is found mainly in lower Orissa in states towards the coast such as Ranpur, but even more commonly in cool valleys at high elevations in the hills of Mayurbhanj, Bonai and Keonjhar. Here *sal* attains a large size. Several of the species mentioned above are found in this type also, but in addition numerous evergreens are met with. Mention may be made of *Mangifera indica*, *Elaeocarpus robustus* (rare), *Mallotus philippinensis*, *Actinodaphne angustifolium* (rare), *Pterospermum heyneanum*, *Bursera serrata*, *Webera corymbosa*, *Dillenia pentagyna*, *Clerodendron infortunatum*, *Michelia champaca* (in cool shady ravines at high elevations) and several species of *Ficus*. *Cedrela toona* occurs in valleys over 2,000 feet but is not common except in the south of Kalahandi. Numerous other species occur but the above are the most important or typical. Mention must, however, be made of *Bambusa arundinacea* which is found together with *sal* in semi-evergreen forest in Ranpur and Dhenkanal States and elsewhere in the south-east of the Agency. In damp valley bottoms in this type of forest, especially in lower Orissa, this bamboo frequently usurps the ground to the exclusion of all other species.

Dry mixed deciduous forest with several xerophilous species covers a considerable area, chiefly in the west in Patna and Kalahandi States, adjoining Raipur district of the Central Provinces, the chief species being *Anogeissus latifolia*, *Terminalia tomentosa*, *T. chebula*, *Bassia latifolia*, *Zizyphus xylopyra*, *Diospyros melanoxylon*, *Buchanania latifolia*, *Acacia catechu*, *Bursera serrata*, *Lannea grandis*, *Garuga pinnata*, *Grewia* spp., *Bridelia retusa*, *Cleistanthus collinus*, *Dalbergia latifolia* (rather scarce), *Ougeinia dalbergioides* (rather local), *Pterocarpus marsupium*, *Dillenia aurea*, *Cassia fistula*, *Aegle marmelos*, *Chloroxylon swietenia*, *Elaeodendron glaucum*, *Schleichera trijuga*, *Semecarpus anacardium*, *Schrebera swietenioides*, *Gmelina arborea* (scarce), *Gardenia gummifera* (on clay with quartz pebbles),

G. turgida and occasional *sal*, with *Sterculia urens*, *Gardenia latifolia*, *Cochlospermum gossypium*, *Boswellia serrata* (in the west of Orissa only) and *Nyctanthes arbor-tristis* on hot, stony, exposed hillsides. *Sabai* grass (*Pollinidium angustifolium*) occurs commonly on clay and lime soils. The common bamboo (*Dendrocalamus strictus*) is often found in association with this type of forest, forming a dense under-storey, or as an almost pure crop with a few *Ougeinia dalbergioides*, *Pterocarpus marsupium*, etc.

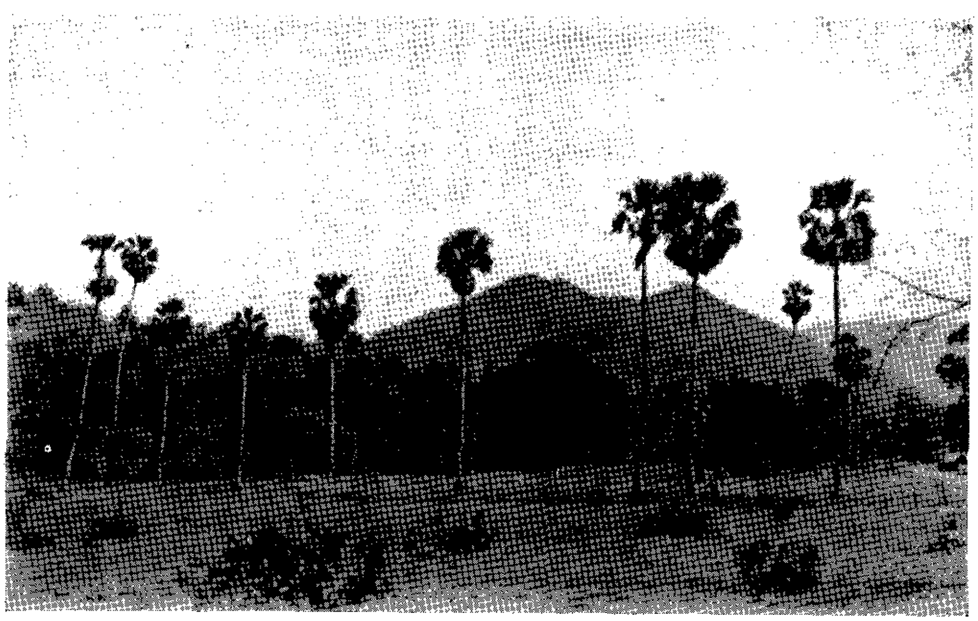
Dendrocalamus strictus occurs mainly in the centre and west of Orissa, being found most abundantly on rather dry rocky hills. It is rare in the north where *sal* forms very pure crops and is scarce towards the coast where its place is taken by *Bambusa arundinacea*. It is abundant in Angul district and in the states along the Mahanadi, *viz.* Daspalla, Baudh, Athmallik, Rairakhol and Patna.

Bambusa arundinacea is absent from the north and west of our area becoming increasingly abundant as one proceeds south-east towards Cuttack and Puri. It is locally very prolific along *nalas* in Athmallik Angul district, Daspalla, the east of Baudh, Hindol, Narsinghpur and the states close to Cuttack. It forms impenetrable jungle and occupies considerable areas to the exclusion of all else. It is of interest that as one approaches the more humid coastal region, this species ascends higher up the hills until it is found at over 2,000 feet in Ranpur State. Further inland it is only encountered along streams and on deep alluvial soil in valley bottoms.

Teak occurs as a special type or consociation in dry mixed forest in the south-west of Patna and the north-west of Kalahandi States along the border of the Central Provinces, where it is found sporadically over a tract of about 150 square miles in extent. Teak forest must have occupied a considerable area in the alluvial valley of the Tel before the spread of cultivation, if one is to judge from the numerous small isolated patches that are still to be met with. The more important areas are now confined to rather hilly ground in the reserved forests where the height of the crop seldom exceeds 60 feet.

View up from Tikepara Ghat, Angul Division on right and State on left of Mahanadi River.

P 809 *Photo H. G. Champion.*



Typical Orissa Scenery, *Mixed deciduous forest on the hills. Bambusa arundinacea* and *Borassus.* Note also open wove bamboo fences, Jaganathpur, near Angul, B. & O.

P 860 *Photo H. G. Champion.*

Another species worthy of individual mention is *Xylia xylocarpa,* since it has rather a curious distribution, the reason for which has not yet been investigated. It is common in places on sandstone towards the coast in Dhenkanal and Athgarh States, extending from them across the Mahanadi into the north of Puri district, where it forms considerable pole crops but does not attain a large size. It reaches large dimensions but is of less frequent occurrence in the hills of Baramba and Narsinghpur on metamorphosed sedimentary rocks, but ceases abruptly close to the eastern boundary of Angul district and is not found in the westerly states until one reaches the extreme south of Kalahandi where it is found sparingly together with *sal* at about 2,000 feet elevation. It occurs rather rarely in Mayurbhanj, Pal Lahara and Bamra east of the Brahmani on metamorphic rocks of the Dharwar system.

In the south-easterly states of the Agency, a distinctive type of semi-evergreen forest is met with, resulting from the more humid conditions prevailing under the influence of the coastal climate. Much of this tract is in a state of " induced scrub " as a result of excessive grazing and hacking in the past, from which the forest is only slowly recovering. *Strychnos nux-vomica* is the most important tree among a host of thorny, shrubby species, amongst which are found *Flacourtia ramontchi*, *F. sepiaria*, *F. cataphracta*, *Phyllochlamys spinosa*, *Limonia acidissima*, *Memecylon edule*, *Xylia xylocarpa*, *Pterospermum heyneanum*, *Carissa* spp., *Webera corymbosa*, *Randia* spp., *Ochna squarrosa*, *Zanthoxylon budrunga*, etc. *Strychnos nux-vomica* is particularly partial to laterite soils and occurs in states along the Mahanadi as far west as Angul, being perhaps most plentiful in Athgarh and Ranpur. It is rare in high forest, preferring the open village forests and waste lands at lower elevations. In fact, the above forest is found exclusively in the plains and on low rocky hills; while the type described as " damp type *sal* forest " is more representative of the better class of forest in the more hilly regions of the humid zone.

The descriptions of the main types of forest given above are naturally rather summary and the lists of species are far from com-

plete. However, it can be seen that the area may be conveniently divided into three main regional types as follows :—

I. The humid coastal region of the south-east within which two main types of forest may be recognised, namely (*a*) the damp type *sal* forest with evergreen species, and (*b*) the semi-evergreen forest on sandstone and laterite with *Kylia* and *Strychnos* as typical trees. *Bambusa arundinacea* is found throughout this region and constitutes a dominant consociation in many places.

II. The *sal* region, represented by the dry type *sal* forest. This is the typical formation of our area, is essentially tropophilous, and covers the bulk of the Orissa Agency.

III. The dry deciduous mixed region, which is met with mainly in the extreme west, in Patna and Kalahandi States, but which occurs here and there wherever conditions are exceptionally dry. Falling within this region is the teak consociation marked by the presence of teak among species which belong essentially to the dry deciduous mixed type. *Dendrocalamus strictus* is very typical of this class of forest, and although it does not justify the formation of a separate regional type, it forms extensive pure crops which may be regarded as bamboo associations.

History.—The history of the forests of the Orissa States resolves itself into two phases : (1) The period before the introduction of regular management, *i. e.*, prior to 1910; and (2) 1910—1933 the period of development along scientific lines.

Prior to 1880 hardly any reference to forests or forestry is to be found among the records, beyond brief references to the extensive jungles occurring in the diaries of early travellers and officials. In fact, before the extension of the Bengal Nagpur Railway from Khargpur to Nagpur, these forests had no commercial value whatever and, as the states reaped little benefit from them, they were virtually untouched except where the aborigines practised shifting cultivation on the hillsides. The only income derived by the rajas from their forests was in the form of a fuel cess levied on the tenants for the use of the jungle but which, as far as can be

ascertained, does not appear to be of very ancient origin. At any rate it was not universally collected in all states much before 1890. In the vicinity of the town of Cuttack some timber was exploited to supply local requirements, but otherwise there were no fellings on a large scale.

The period 1883—1900 was one of considerable railway development. The extension of the main Bengal-Nagpur line to Nagpur and the construction of the East Coast Railway being the more important projects associated with Orissa, traversing as they do the northern and eastern boundaries of our area. These railways, especially the former, passed through or close to some of the finest and most extensive *sal* forests of Orissa, *viz.*, those of Bonai, Bamra, Gangpur and Keonjhar, which are adjacent to the Government forests of Singhbhum district. Large timber companies soon sprang up and were not long in seizing an opportunity of obtaining the grant of several concessions, frequently for lengthy periods. The *sal* forests of Khandpara, Daspalla, Nayagarh, Ranpur, Baramba and Dhenkanal were also heavily exploited by petty contractors to supply sleepers to the East Coast Railway. So heavy was the felling in this latter area, which is not so rich in *sal* as that already mentioned, that even now there are few sound trees of exploitable size to be found in these states.

For twenty years this work continued without regard to the capacity of the forests. New leases were granted, old ones were renewed and the work spread further and further afield to any forest which was within exploitable distance of the railway. The leases contained hardly any clauses relating to the proper management of the forests or to the economic conversion of timber, while in few instances was any limit set to the number of trees to be felled in any one year or during the period of contract. The result was that the more accessible areas were heavily over-exploited, the forests of Gangpur suffering most owing to their proximity to the railway. This latter state, which is said to have contained some very fine timber, was stripped of all its large trees and the forests reduced in many instances to pole crops ; nor are they yet in a position to supply large

timber. Any tree that would yield a single sleeper appears to have been felled, as is evident from the size of old stumps. It is hardly necessary to state that the results of these uncontrolled operations are now only too fully apparent; but owing to the natural excellence and extent of the forests, it was some time before its folly was recognised and steps taken to put forest management on a better footing.

About 1904 the question of appointing a trained forest officer to advise and assist the Political Agent and to look after the forest interests of the states was raised, but it was not until 1910 that the first Agency Forest Officer, Mr. A. N. Grieve, was appointed. The credit for his appointment was due in no small measure to the insistence of the then Political Agent, Mr. L. Cobden-Ramsay, C. I. E., on the importance of introducing regular management into the forests of the Agency and the need of a progressive but nevertheless conservative forest policy. From this date the development of the forest resources of the states commenced.

Mr. Grieve was succeeded in 1915 by Mr. G. M. Cooper who held charge of the post until 1920. From 1912 Mayurbhanj State employed the whole time services of a Government Forest Officer, Mr. A. H. Mee, who managed the State forests until his retirement in 1929.

The selection of areas suitable for reservation and their demarcation and survey occupied the next ten or twelve years and left little time for more intensive work; besides which, the application of systematic management was hampered by the terms of many of the existing leases. The staff was almost entirely untrained, funds were not readily available and as a result progress was at first slow. Gradually, however, matters improved and with a steadily expanding income the Agency Forest Officer was provided with greater scope and was able to proceed step by step along the high road of progress.

The first necessity was trained staff. To meet requirements, several Dehra Dun trained rangers were recruited and a few officers of the ranger and forester grade were lent by Government. The nature of the work being essentially simple and practical, it was possible to carry on with a rather limited number of qualified men and

this was also necessitated by the scarcity of funds allotted to the forest department in the various states. By degrees it became evident that the trained staff would have to be expanded if the work was to be carried on satisfactorily. As a result numerous local students were sent to the Kurseong and Balaghat forest schools for training, and later on to Coimbatore. The continued demand for an increasing number of trained foresters led finally to the formation of a forester's training school in Keonjhar State in 1927, the institution being built and equipped at a cost of Rs. 43,000, which was subscribed by the Chiefs for this purpose.

Following the completion of the demarcation and survey, which was all but terminated in 1923, the preparation of working plans became a matter of outstanding urgency. Up till then the forests were being worked (as far as the current leases permitted) along the lines prescribed in the periodical inspection notes of the Agency Forest Officer. While this was quite adequate and still suffices in the smaller states, it was obvious that regular working plans were an urgent necessity in the states of greater importance. The first regular working plan was prepared in 1924 and since then the compilation of further plans has absorbed a large proportion of the Agency Forest Officer's time. The area at present under regular working plans is 3,134 square miles of reserved and 330 square miles of protected forest. Working plans for a further 873 square miles are in course of preparation and in addition there are considerable areas of forest in the smaller states which are being managed in accordance with working schemes embodied in inspection notes. This work has been somewhat hamperd by the conditions of some of the long timber leases, but as the latter expire, plans are brought into operation and future leases (which will be shorter than the old ones) will naturally be bound by the working plan prescriptions.

Potentialities of the Forests.—*Sal* sleepers rank first in importance among the forest products of the Agency, the revenue accruing to the various states under this head being approximately Rs. 5 lakhs. The average output during the past four years has been in the neighbourhood of 2 lakhs of broad-gauge, $1\frac{1}{4}$ lakhs of metre-gauge,

$\frac{1}{2}$ lakh of narrow gauge and some 40,000 irregular sizes. By far the largest individual supplier is Mayurbhanj State. With the exception of Pal Lahara State, where the work is done departmentally, the business is in the hands of a few large timber firms.

Apart from sleepers, there was until the recent slump a very good market for logs (mostly *sal*) in the town of Cuttack, where a thriving boat building industry exists. The boats were mostly exported by canal to the jute-growing districts of Bengal but the existing depression in the jute trade has curtailed the demand for boats and this has reacted on the log business in Cuttack. A small but flourishing furniture-making industry in the same town called for limited supplies of *bija* (*Pterocarpus marsupium*) and *sissu* (*Dalbergia latifolia*) but this market has also been hit by the present trade conditions. The total quantity of *sal* and other hardwoods exported in the round amounts to about 2 million cubic feet annually.

Of considerable importance is the supply of small timber, poles and fuel for local consumption. The necessity for providing the indigenous population with their requirements has not been lost sight of and, where a shortage of village jungle exists, extensive areas of reserved forest have been set aside to supply material for house-building, agricultural implements, fuel and grazing grounds. It is noteworthy that Patna State with a large and prosperous agricultural population, derives 70 per cent. of its forest income of over Rs. 2 lakhs from sales within its own borders. It has been estimated that the consumption of poles for house-building is about 23 million cubic feet and of fuel approximately 226 million cubic feet. Besides small timber for local use, a fair business is done in pit-props and tramway sleepers for the collieries and fuel for the industrial towns in the province, all of which are situated in British India with the exception of the Talcher coalfields. Small supplies of poles, fuel and bamboos find their way as far as Berhampur in Madras from the south-easterly states of the Agency.

Enormous quantities of bamboos are available in the Orissa States, the total annual yield taken by right-holders and sold amounting to some $7\frac{1}{4}$ millions annually. This figure, large as it is, is only a

fraction of the possible yield from the bamboo forests of the Agency, many of which are, however, rather remotely situated. The recent opening up of the Government forests in Angul district by a firm extracting bamboos for paper-pulp is likely to be further expanded to embrace the adjacent states along the Mahanadi, which provides the main outlet and acts as the chief highway for timber and bamboos for several states situated along its banks to the town of Cuttack, which is the largest distributing centre for forest produce in Orissa—the coastal British districts being practically devoid of jungle with the exception of the Government forests in Puri.

Minor produce forms an important item in the total output of the forests, the most noteworthy products being lac, *tassar* silk, *nux-vomica*, *kendu* (*Diospyros melanoxylon*) leaves, *mahua* seeds and oil, myrabolams, *sabai* grass, *catechu* and *sunari* (*Cassia fistula*) bark. Among others of lesser importance *kamalagundi* (*Mallotus philippinensis*) powder and thatching grass may be mentioned.

Lac is by far the most important of the minor products although the low prices which have prevailed for the past three years have done much to curtail the industry. It is estimated that the output is in the neighbourhood of 20,000 maunds. It is of interest to note that lac does not thrive in the moister coastal tracts. In fact it has been demonstrated by experiment that it will not grow within 40-50 miles of the coast and that it does not thrive within 80-90 miles of it. It is very extensively cultivated in the states of Mayurbhanj, Keonjhar, Bonai, Kalahandi and elsewhere.

A considerable revenue is derived from the sale of *kendu* leaves for the manufacture of *birhis* (local cigarettes). This industry is confined mainly to the north-west corner of the Agency in Gangpur and adjoining territory, but has been expanding considerably in recent years; contractors having extended their activities further afield in search of new areas, the leaves being delivered at the railway by lorries operating over leads up to 80 miles. These leaves, although classed as a forest product, are mainly collected from village waste and fallow uplands, where innumerable shoots spring up annually from root-suckers, and these provide the young tender leaves of the consistency required for the manufacture of *birhis*.

The rearing of *tassar* silk-worms on pollarded *asan* (*Terminalia tomentosa*) branches constitutes an important cottage industry in Mayurbhanj and Keonjhar States. The wild cocoons are collected in the jungle and the silk-worms are reared on trees growing close to the villages—often on cultivated lands.

The seeds of *kuchila* (*Strychnos nux-vomica*) are exported from the east of the Agency, especially from states bordering the Mahanadi. Some ten to fifteen thousand maunds are exported annually.

Financial.—As the extent of land under cultivation is in many cases limited, the forest income of the states bears a most important relation to their general prosperity. In Bonai and Rairakhol, over 90 per cent. of the state consists of forest land of one kind or another; while in Athmallik, Daspalla and Bamra, arable land represents less than 30 per cent. of the whole. In some cases the forest revenue is more than half the gross income of the state. The land revenue of 26 feudatory states for the year 1931-32 was Rs. 42,77,606, while the forests yielded Rs. 21,57,505 gross, or Rs. 16,16,177 net income. The following statement shows the average annual gross revenue by quinquennial periods from 1905-06 to 1929-30 and the actual revenue and expenditure for the past ten years:—

Period.		Revenue.
		Rs.
1905-06 to 1909-10	..	6,50,123
1910-11 to 1914-15	..	8,62,000
1915-16 to 1919-20		11,54,205
1920-21 to 1924-25	..	17,73,650
1925-26 to 1929-30	..	25,97,612

Year.		Revenue.	Expenditure.
		Rs.	Rs.
1922-23	..	15,68,127	3,77,758
1923-24	..	18,05,581	3,81,005
1924-25	..	19,90,284	4,24,945
1925-26	..	23,57,758	4,81,746
1926-27	..	24,71,765	5,13,201
1927-28	..	26,32,976	5,73,284
1928-29	..	26,83,733	6,72,333
1929-30	..	28,41,628	6,21,707
1930-31	..	24,20,689	5,67,599
1931-32	..	21,57,505	5,41,328

The forest income has shown a steady expansion as the forests have been developed and there is every reason to believe that this progress will be maintained as further areas are opened up.

The outlook is excellent since the forests are not being worked to anything like their full capacity and are capable of yielding much more than at present. A setback has been experienced during the past two years owing to the general trade depression, the slump in the price of shellac, the declining prices of timber generally and sleepers in particular. However it is hoped that there will be a return to prosperity in the near future ; and if it is borne in mind that the prices ruling during the past decade were abnormally high, it will be clear that the future policy must aim at a more intensive development of resources and an expansion of markets rather than at an increase in rates. Lower prices are inevitable ; and this must not be regarded as an altogether unhealthy sign. Indeed, if timber is to compete successfully with its serious rival steel, it can only do so by maintaining a low competitive price.

Silviculture.—The progress in the preparation of working plans has already been referred to. The underlying principle in all plans has been simplicity of treatment combined with the maintenance of a sustained yield. Highly technical and involved plans would only handicap the work as there is insufficient trained staff to execute them. It may be considered desirable at some future period to indulge in more elaborate plans ; but for the present complicated technicalities are best avoided.

In the case of high forest, the Selection System combined with improvement fellings has invariably been adopted owing to its general suitability to local conditions. The yield is based on enumerations down to 12 inches diameter and covering the complete forest in most cases ; it will be regulated by periodic re-enumerations. In one or two instances the yield is controlled by area where the forest is extensive and the crop of poor quality. The felling cycle has been fixed rather high, being 30 years in most cases ; but this will no doubt be shortened when the plans are revised. There is at present need for a conservative policy in several areas owing to past

maltreatment. The Conversion to Uniform system has not been employed, partly as it was not considered generally suitable but largely on account of the enormous waste of small material involved in forests where no market exists for anything below 16 inches in diameter.

A very considerable area is being worked as coppice on rotations varying from 25 to 60 years, according to the quality of the forest and the requirements of the market. Forty years is the rotation most commonly adopted, but long rotation coppice or preferably "coppice-selection" has much to recommend it in certain localities.

Thinnings have been prescribed in all areas under regular working and have already been carried out in several of the earlier coppice coupes. Improvement fellings have been executed in many of the older crops, especially in those that have been heavily exploited in the past. A considerable sum of money is spent annually on these operations as well as on climber-cutting and cleanings.

Fire protection has been extended to all reserved forests and in some states a very high percentage of success has been achieved. The danger of prolonged protection in the moister type of forest has not been overlooked and provision will be made to deal with this problem. At the present stage of development, however, it does not appear opportune to relax the existing system of protection especially in the drier forests in the west of the Agency. At the present juncture it is desirable to develop a certain "forest sense" among the local population and the inculcation of a greater respect for the forest is highly desirable.

Artificial regeneration.—A good deal of money was spent between 1911 and 1922 on small scattered plantations, which was productive of very little visible result. The present policy is to avoid plantations except where they are urgently required and where it is proposed to plant areas of some extent, and to concentrate rather on improving and developing the existing resources of the Agency. This is likely to prove more profitable in the long run and there is less chance of money being wasted.

A plantation of some importance was initiated in Keonjhar State in 1930 with the object of reclaiming some 1,000 acres of good arable land which had been completely inundated with sand as a result of the phenomenal flooding of the Baiturani in 1927 and been rendered unfit for cultivation. This is being planted up with *Casuarina equisetifolia* and *Dalbergia sisso*, the results hitherto being most encouraging, especially in respect of the *sissu*. Some 300 acres have been planted with teak in Patna and there is a scheme in the same state to plant up about 1,000 acres with *babul* and *sissu* to supply local requirements in an area which is rather short of forest.

Roads and buildings.—The total length of road constructed by the forest department only amounts to between 50 to 60 miles. However, a good system of unmetalled main roads is in existence and sufficient cart tracks have been made by contractors and others to supply all existing needs. As time goes on no doubt better roads will be built but for the present it seems undesirable to launch forth on expensive road programmes, departmental work being confined to the opening up of inaccessible areas when necessary. As the forest staff tour exclusively by pony, bicycle and on foot, the improvement of roads for purely inspectional purposes is objectless. And there is something to be said against the automobile as a means of forest inspection!

The building programme has been more progressive, and very few years more will see the whole staff adequately housed. During the past six or eight years this work has been pushed forward rapidly until now practically every range officer and many foresters have brick built quarters and offices. The cost of a range quarters varies from Rs. 1,500 to 3,000 according to the importance of the range and the financial condition of the state. Whereas formerly the forest guards lived in their villages, they are now provided with good mud huts in the vicinity of their beats. It is hoped that the improved conditions in respect of housing accommodation will be reflected in the better health of the staff and a consequent all-round improvement in the standard of efficiency.

Staff.—Perhaps in no other direction has progress been more apparent than in the quality of the executive staff. Prior to 1910

there were not more than two or three trained forest officers in the whole Agency. The existing staff consists of one Dehra Dun Provincial Service Course officer, four Dehra Dun rangers, 12 Madras Forest College rangers, 29 Kurseong foresters, four Balaghat foresters, 60 Orissa School foresters, and about a score of others who have undergone the practical courses at Kurseong and Russelkonda, in addition to which there are numerous untrained foresters. It is a sign of the importance attached to forestry that the Ruling Chief of Keonjhar deputed his State Forest Officer to the Imperial Forestry Institute at Oxford in 1929 to undergo a refresher course with the object of keeping himself in touch with modern practice and the latest technique. Although progress in forest education in the Agency has been considerable, much still remains to be done and it will still be some years before the states can consider that their forest staff is adequate in numbers and qualifications.

Shifting cultivation.—Although much has been done to develop the forest resources of the Orissa States and though there is much to justify optimism in the present condition and the future outlook of forestry in the Agency, one blot still remains on the record of forest administration, namely that the practice of shifting cultivation is still permitted to continue. For the past twenty years successive Agency Forest Officers have inveighed against it, but it is only within the last three or four years that the matter is at last receiving serious attention. This was largely due to the devastating floods on the Baiturani in 1927, which focussea attention on the matter, as they could be directly traced to extensive disforestation and denudation in the catchment areas of the river. It is not enough, however, that the seriousness of the situation should be deplored. It is time that active steps were taken to limit and finally abolish this destructive method of raising crops. It is true that difficulties will be encountered with the tribes who practise *jhuming* but it is in the interest of the community in general that a stop should be put to it.

Fauna.—A considerable variety of game is to be found in the Orissa states. Elephants are to be met with throughout the area north of the Mahanadi from Bamra in the west to Mayurbhanj, Nilgiri and Dhenkanal in the east. Their westerly distribution ceases about

fifty miles from the boundary of the Central Provinces while it is doubtful if any but a few stragglers find their way into Midnapur district of Bengal. They are most plentiful towards the north-east, occurring in large numbers in the forest clad hills of Mayurbhanj. One isolated herd of some fifty individuals occurs south of the Mahanadi in the east of Kalahandi State. *Khedda* operations are carried out almost annually in several states, the yearly catch being in the neighbourhood of thirty or forty animals. In 1930-31 the catch was 101 animals. The ivory carried is of fair size, tusks of over 100 lbs. the pair being not at all unusual.

The wild buffalo (*Bubalis bubalis*) extends from the south of Raipur district in the Central Provinces into Patna, where a herd numbering about fifty inhabits a rather limited area along the western boundary of the state, close to the teak bearing tract. Odd individuals occasionally cross the Tel river into Kalahandi State. They have been rigidly protected for the past ten years.

The *gaur* is common throughout, though rather scarce in Patna and the west of Kalahandi. Sambhar are fairly plentiful but large heads are scarce, anything over forty inches being extremely rare. The *chital* or spotted deer is commonly met with except in the more hilly areas. A head measuring 39¾ inches is recorded from Bonai State. Barking deer and the four horned antelope are universal. The swamp deer is not found in our area though met with not far from its north-westerly boundary in the Central Provinces. The *nilgai* is not very common and is rather local in distribution. The mouse deer is met with everywhere. The blackbuck is found only in parts of the north and west of Kalahandi and Patna, where it is scarce and the heads small.

The carnivora and those animals that may for convenience be classed with them include tiger, leopard, sloth bear, hyæna, wolf, wild dog, wild cat, ratel, jackal, two civet cats, otter, etc.

The Central Indian squirrel is common in all large *sal* forests and the *oral* or flying squirrel (*Pteromys oral*) is found in the forests of Singhbhum and Bonai. Game birds comprise peafowl, the red

jungle fowl, the common and painted spur-fowl, the grey and painted partridge, the imperial, green and blue rock pigeons, three migratory snipe, at least two varieties of quail, four resident and numerous migratory ducks.

Conclusion.—This brief account would be incomplete without a reference to the increasing personal interest which has been evinced by the Ruling Chiefs in the management of their forest estates. Formerly there were few amongst them who realised the valuable property they possessed in their extensive but undeveloped jungles. But the last two decades have seen a great change, and it is hoped that the lessons of the past have been well learnt. One has only to refer to the figures of revenue and expenditure, already quoted, to appreciate the financial benefit that has resulted from the reorganisation of the department in the several states of the Agency. The future of the forests is now assured if the present policy is adhered to and pursued to its conclusion.

In spite of the advance registered since 1910, it is in no way derogatory to past achievement to say that there is scope for considerable development before the position can be regarded as entirely satisfactory. The sums hitherto expended on the forest department have been the bare minimum necessary for maintaining a moderate level of efficiency and have in most states been much less than 25 per cent. of the gross income. In these times of trade depression there will be a general tendency to economise in all administrative charges, to restrict development, and above all, to curtail establishment. While extravagance is to be condemned, excessive parsimony is equally reprehensible and would be all the more deplorable in the present case, since forest administration in the Orissa States is still in the earlier stages of development. Ill-conceived economy at the present juncture is certain to have serious consequences and to retard the expansion that will undoubtedly follow in the wake of returning general trade prosperity and would undo much of what has been laboriously achieved since the inception of forest administration on regular lines. The unusual importance of this large forest tract, both to the individual owners and to the province of Bihar

and Orissa as a whole, is a matter the importance of which cannot be over-emphasized owing to the shortage of reserved forest in the British districts and the steadily diminishing area of forest outside the reserves.

EUROPEAN SILVICULTURAL RESEARCH, PART VI—ARTIFICIAL REGENERATION.

BY H. G. CHAMPION, I.F.S.

Planting and sowing have been so widely relied on for regenerating the forests of Central Europe, that I entertained hopes of being able to see some comparative studies of different methods, and in this I was not disappointed. Three of these studies, now 50, 40 and 30 years old, respectively, merit a cursory review from the point of view of technique and results obtained.

(*i*) 1872 *spruce plots at Wermsdorf, Saxony.*—This set consists of 19 quite large plots in a double row surrounded by a plantation of the same age not under special observation. The area is exceptionally uniform, and such minor soil variation as has been shewn to exist is largely cancelled by the juxtaposition of plots of closely similar treatment. The treatments cover both method and spacing; they comprise broadcast sowing, single and bundle planting, and mound planting, with spacing varying from 0·8 to 2·1 meters, in squares or lines. The results were last analysed in 1925 by Busse and Jæhn (*Mitt. Sächs. forstl. Versuchsanstalt.*—II, 6, pp. 200—281) mainly from the point of view of the effect of varying growing space on increment. It was found that for average requirements, a growing space of 1—3 square metres should be considered normal; closer spacings such as are obtained from broadcast sowing proved definitely unsatisfactory on all counts: wider spacing of 3—4 square metres is recommended where small material is unsaleable; and anything wider still—say over 10 × 10 feet,—shows a pronounced drop in timber value in consequence of extra knots and branchiness, though there is very little loss in volume production. The mound planting gave good

results under the local conditions. Square spacing appeared preferable to lines. It struck me that more use might have been made of the surrounding plantation as a common control for the whole set, providing some measure of the significance of the sometimes rather small differences compared, but the investigation is an exceptionally instructive one.

Saxony has an even older similar investigation with Scots pine dating back to 1862, duplicated in two localities, Markersbach and Reudnitz. I was unfortunately unable to visit these places, but Busse and Weissker have recently described them (*loc. cit.* 1931 pp. 309—51) and I was able to learn about them at first hand from Dr. Busse. As might have been expected, the conclusions to be drawn *differ appreciably from those reached for spruce, and for total value* production, the wider spacings (none exceeded 6′ × 6′ however) show to advantage. Once again square spacing shews up better than lines. The pine is able to make full use of available space much more quickly than can spruce. The very cautious concluding remark of the authors of the note is worth quotation.—" This investigation has not given a clear answer to the main question :—what spacing should be given in pine plantations ? It could not do so, for this and similar questions cannot be solved entirely on yield data : our whole equipment, both scientific and that won by practical experience, is needed to find the correct solution for the given conditions." The last four words of this extract are the key to its whole purport, and it directs the attention of the research worker to the paramount importance of so selecting the site for an investigation, and so conducting it that the results it may give will be applicable to as wide a tract as possible ; it also warns him once more against unjustified generalisations and provides the self-styled " practical " forester with an instance showing that research workers are as aware of this risk as their critics, and perhaps avoid it more often than they.

(*ii*) 1882 *spruce plots at Kocherhof*, *Baden*.—This set of plots has already been referred to in connection with mixture of species with which it also deals. Line sowing, nursery plants and natural seedlings were tried in various spacings. The results were last published by

Hansrath and Ganter in 1923 (*Allg. Forst. u. Jagd. Ztg.*, 1923, pp. 217—26). Once again, the wider spacings result in a significant loss in timber value. Close spacings slows up height growth at first but the loss appears to be made up later.

(*iii*). 1892 *spruce plots at Mariabrunn, Austria.*—Here also, planting space is the main point studied. There are four half-acre plots with 1×1, $1\frac{1}{2} \times 1\frac{1}{2}$, 2×1 and 2×2 metres spacing, respectively. At the 1923 assessment, the plot with the widest spacing led definitely in average height and diameter, and the trees did not appear appreciably more branchy than in the denser plots.

The deductions for us from these old experiments, which are unfortunately nearly all for spruce, are that species vary considerably in their ability to utilise the available space given them in a plantation; that relatively close spacings may give the maximum total volume production but react unfavourably on height and diameter growth, and resistance to injuries, and that a limit is very quickly reached beyond which economies in plants and planting costs are more than offset by depreciation in the value of the timber grown. Square spacing appears to give somewhat better results than line spacing. Differences between sowing and planting as such have not been analysed from the results of the different spacings resulting.

On this subject of planting space, the most interesting recent development is to be found in Great Britain. It has been described by its originator, Dr. M. L. Anderson, in *Scot. For. Journ.* 44 (2) pp. 78—87 and *Quart. Journ. For.* 1931 pp.312—316, and has been discussed in the English forestry periodicals. The underlying idea is to get the benefits—they appear undoubted in the case of oak at least—of close spacing without the high cost involved in the use of a large number of plants per acre. It is proposed to plant out in closely spaced groups, leaving the intervening space unplanted. The number of groups per acre may approximate the number of trees expected to form the final crop. It is suggested that the idea is particularly applicable for mixture of species (each group being of one species only) and that natural regeneration very usually comes up groupwise, the groups finally merging to make a full canopy. In the forest of Dean the

idea was being further developed by filling up the interspaces with a quick growing coniferous crop to give some early returns. One is inclined to think that though the idea may have points in its favour under cool temperate conditions, it would be unsuitable to more luxuriant tropical and subtropical forests. Its parallelism with Bombay's *rab* system of teak regeneration may however be noted.

In connection with its extensive afforestation work, Great Britain has many investigations under way on details of plantation technique, several of which have already been touched on, notably those more connected with soil problems. Several series are concerned with age and type of nursery stock to be used for best results, a problem we encounter with deodar and some of the slower broadleaved species; in these one noticed the need of care that really comparable stock is used and that whatever differences there may be are carefully recorded. Another complication to be avoided is connected with the need for beating up the plantations, and the conclusion seems indicated that in many experiments one should draw two sets of deductions from the end results, one for the plot as a whole, and one for the survivors of the original planting only.

An interesting experiment carried out on quite a fair scale was seen at Tharandt, where Dr. Münch, perhaps spurred on by the post-war urge to economy in planting costs, had planted out several sets of plants for comparing ordinary pit planting with the far more expeditious and cheaper oblique notching, with pine and spruce. The result is rather unexpected in that there is no visible difference in development between the two sets and the casualties are actually less for the notched plants. This may be compared with the small differences found by more than one investigator in India as between pit planting and crowbar planting of stumps, and the lack of return on extra cost often found for extra depth of soil working beyond a certain minimum.

We foresters not infrequently charge the engineering fraternity with an unjustifiably high standard of material, work and cost insisted on when running up a temporary tramway, road or bridge, but I think we may sometimes be open to the same charge in some of our plantation work when we carry it out under the most favourable

conditions with all the elaboration essential in unfavourable localities. I hope this remark will not be interpreted as condoning slovenly planting work!

I did not see anything calling for special comment in the forest nurseries inspected, above all on the Continent where, in fact, I thought the standard was below good Indian work and experimental technique was mostly only poorly developed. The British Forestry Commission's nurseries, however, are well worth a visit, being on a far larger scale than anything we have. A marked point of contrast with Indian practice is the routine use of hedges round blocks of nursery beds, any detrimental effect from competition or shade being more than marked by the benefit of the protection afforded. Many examples of nursery experiments covering density and depth of sowing, nature of seed covering, watering and shading, etc., were seen. Such investigations provide ideal conditions for the application of modern methods permitting statistical analysis of results, as exemplified by Dr. Steven's publication (*For. Com. Bull.* No. 11). A useful detail is the adoption of a pair of beds, or half-beds, as the unit, permitting the exclusion of one if some chance mishap such as cockchafer attack spoils it. A fallow, or green manuring cycle is aimed at in all the permanent nurseries seen, but it is difficult to adhere to in practice owing mainly to un-anticipated demands on the available space.

The use of exotics requires brief notice. On the Continent, experience does not appear to have been very happy despite very numerous and fairly extensive trials.

Pinus strobus is a good example of an exotic full of early promise which has now to be written off. Douglas fir is still looked to hopefully, but confidence in its future is not yet generally established. In Britain, Sitka spruce is the present favourite and certainly seems to do very well under the right conditions. *Pinus contorta* is also promising. Of course, many European species such as larch and spruce have done well a long way outside their original range, and it is clear that the extra help the forester can give, particularly against competitors, is all that is required to enable them to hold their own and develop satisfactorily.

Despite the reaction of recent years in favour of natural regeneration and the avoidance of clear felling, artificial regeneration continues to be practised over very large tracts. Sowing is preferred on account of its low costs where it can be done with good expectation of success, but early reduction of the number of plants to about what is used in plantations is found to be desirable on many counts. Planting costs can sometimes be cut down by simplifying procedure where it is more elaborate than conditions demand.

Spacing in plantations cannot be appreciably increased beyond a rather small figure without ultimate loss in timber value. Extension of a species considerably beyond its natural range may give excellent results (even if natural regeneration becomes difficult or impossible), but extensive use of exotics in the narrower sense is a risky gamble.

PRELIMINARY NOTE ON THE SHOT-HOLING OF CONVERTED TEAK.

By D. J. Atkinson, I. F. S.

[A report giving similar conclusions was printed in our January 1933 issue as an extract from the *Timber Trades Journal,* and we are glad to have this further opportunity of issuing an authoritative denial to the reports which have appeared in some of the Home papers indicating that this shot-hole attack was serious.—*Ed.*].

It is unnecessary in this preliminary report to give in detail the history of the recent complaints regarding this " shot-hole " in teak. It is sufficient to note that within the last three or four months some ½ dozen or so consignments of converted teak belonging to the Bombay-Burma Trading Corporation, Ltd., Steel Bros. & Co., Ltd., Foucar & Co., and the Trading Co., have been reported by their Home representatives as having arrived in a " wormy " condition. Very lately, also, 3 parcels of *gurjun* belonging to Messrs. Steel Bros. have also arrived in a damaged condition, shot-holing having been reported up to 25 per cent. Messrs. Steel Bros. submitted a specimen of damaged timber to the Forest Products Research

Laboratory, Princes Risborough, and about the same time Messrs. The Bombay-Burma Trading Corporation, Ltd., sent a similar piece to the British Museum. The reports on the examination of both these pieces of timber are very similar. Princes Risborough reported finding several living specimens of *Tribolium castaneum* and one dead specimen of *Dinoderus pilifrons*, and were of the opinion that the galleries found in the teak had been excavated by the latter and that the former species was present merely for shelter. Mr. Laing of the British Museum also found *Dinoderus* present in the pieces submitted to him. Princes Risborough further reported that no gallery opened was found to extend beyond ½″ into the timber, the majority being within ¼″ of the surface. Neither authority was of the opinion that the damage already evident would extend or that there was any likelihood of the beetle breeding in teak.

2. The only specimen of rejected timber so far received back in this country is a plank of teak originally shipped by the Trading Co., and part of their consignment rejected in Europe. One should therefore be safe in assuming that this plank represents an average sample of the damage. The plank has been thoroughly examined by me : it was reported to show 25 holes ; of these, one was caused by a species of *Xyleborus* (family *Scolytidae*) or by one of the *Platypodidae*, the true ' ambrosia ' beetles, and must have occurred before conversion and therefore been present in the plank when shipped. One other hole was not caused by an insect but by some instrument used for handling merchandise on shipboard. The remaining 23 holes were undoubtedly excavated after conversion, and were, in my opinion, caused by *Dinoderus pilifrons*, the bostrychid beetle in question. All holes were gouged out until cleared. In no case did they penetrate to a greater depth than half inch and the majority were within ¼″, many merely grazing the surface. In one hole a dead specimen of *Dinoderus pilifrons* was obtained. For purposes of demonstration this plank was then skinned at ¼″ on all four faces. The residual piece of timber was then sawn in half. As demonstrated to representatives of the timber firms on 7th November 1932, no hole passed within the ¼″ skin and saw-kerf and the interior of the plank was perfect.

In fact, no more damage had been done by the insect than by the hooks, etc., used in moving the plank on the ship.

3. *Dinoderus* is a genus of the family *Bostrychidae*, the Powder-post beetles. The usual host plant of the whole genus is bamboo, but they are also recorded from canes and starchy roots of various sorts. One species only, *bifoveolatus*, has been recorded from the tree species of *Artocarpus* and *Sterculia*. Much work has recently been done on this genus in Dehra Dun, and it is practically impossible to believe that, were it a true borer of so important a timber as teak, this fact would never have been recorded before.

4. The true home of the beetle being in bamboo it became at once desirable to see what possible connection there could be between bamboo and the converted teak under consideration.

It was learned that ships sailing from Rangoon are in the habit of using bamboo as dunnage and it seemed likely that this bamboo dunnage was the source of the trouble. A visit was therefore paid to the S. S. " Amarapoora " and the S. S. " Gloucestershire " then in port. The " Amarapoora " had just arrived on her return from the voyage in which Messrs. Steel Bros.' *gurjun* above referred to had been damaged and still contained a certain amount of the old dunnage. The " Gloucestershire " had not so far experienced any damage to cargo. In both ships the bamboo dunnage was found to be heavily attacked by *Dinoderus*, living beetles and larvæ being discovered with ease. It had also been claimed that the bamboo matting used as dunnage was subject to attack and one of the Bombay-Burma Trading Corporation's letters from Home refers to this matting as swarming with the beetle in question. In fact, however, no signs of borer were found in the bamboo matting and I am of the opinion that it would not be possible for *Dinoderus* to exist therein, as the strips of which it is made are not of sufficient substance. The matting was, however, swarming with countless numbers of *Tribolium castaneum*, the common Grain-beetle, and doubtless the report from Home just referred to really concerns this insect. The permanent dunnage of both ships was also examined. This originally is part of the ship's construction, and though of course frequently damaged

and repaired, is said to be always so repaired at Home and to consist invariably of coniferous timber, deal, etc. This was found to show holes exactly similar to those complained of in the teak and consequently a length from each ship was brought to the Depot for examination; in the case of the "Amarapoora" from amongst the lattice work on the sides of the ship and in the case of the "Gloucestershire" a piece of the movable dunnage laid down on the bottom of the ship to form the base for all the cargo. On subsequent examination both these pieces of deal dunnage were found to be attacked exactly as described above for the Trading Co.'s rejected teak plank, *i.e.* the holes were undoubtedly caused by *Dinoderus*, penetrating only a short distance, and showed no signs of the insect having bred in them. I was fortunate to find, in the case of each piece, a single dead specimen of the beetle. It was also of interest that in several cases the holes had been made previous to the last painting or tarring of the hold, as the black paint obviously had entered the galleries.

5. It is practically impossible to believe that an insect whose normal food is bamboo could subsist on either the seasoned heartwood of teak or the resinous wood of deal, and I am personally of the opinion that the attack both on teak and the deal dunnage has been purely accidental, and also that it must have been of frequent occurrence in the past. I also consider it likely that any timber shipped with bamboo dunnage would be found on examination to contain these incipient galleries and that, for instance, the wood of crates and packing cases and of the tea chests shipped from Ceylon would also show these borings. I consider it probable that the recent investigations at Home on the depredations of *Lyctus*, combined with the low state of the timber market, have resulted in timber now arriving in Home ports receiving considerably closer examination than in the past, and it is natural that once a consignment of Burma teak fell into disfavour through reported "worm" holes every subsequent consignment should have been examined with particular thoroughness. In my opinion the bamboo dunnage, holding a heavy population of the borer, has produced a generation of beetles during the voyage, and these, which in nature would flight in search

of fresh bamboos in a suitable condition for attack, have in the confinement of a ship's hold merely been able to crawl amongst the cargo. In thus crawling they have penetrated between two pieces of teak, or behind the ship's dunnage, or between other cargo and the dunnage, and finding themselves unable to progress further have commenced to bore in. Not finding the substances they require in these strange hosts they have vacated or died. I questioned the ship's officers and also the *khalasies* as to whether they had ever experienced the production of frass from the ship's dunnage. Any native knows the *goon* produced by these Powder-post beetles and this would certainly have been obvious enough on the undisturbed bottom of the ship if the breeding of the beetles had ever caused its production. No one had ever seen it, though they are familiar with the similar *goon* produced from the bamboos. I do not agree with the extracts from the report of " the entomologist " quoted by Messrs. Bibby & Co., in their recent letter to Steel Bros. I have not experienced the prolongation of the gallery in the longitudinal axis of the tree referred to therein, nor, I gather, have Princes Risborough or Mr. Laing of the British Museum. It is, however, not improbable that these did occur, though I cannot agree that they could have been constructed by a bostrychid larva, or that the description of them gives any grounds for thinking that the insect had reproduced in these galleries.

6. I do not doubt that the damage has occurred on the ship. I have examined stocks in Steel Bros. Mill and in a less detailed manner in The Bombay-Burma Trading Corporation's Mill and I am prepared to certify that their stocks of teak are clean. There are only two conditions under which converted teak heartwood could show shot-holes (as distinct from small beeholes or longicorn holes). Several species of ***Xyleborus*** (*Scolytidæ*) and *Crossotarsus* (*Platypodidæ*) attack the sapwood of recently dead teak, and these small galleries do, in fact, penetrate the heartwood up to about an inch, so that a scantling taken from very close to the sap might show these small shot holes. They would, however, in any case be distinct from the shot-holing in question by almost certainly showing a white incrustation within the aperture and probably slight staining round the hole.

The single hole in the Trading Co.'s rejected plank referred to above as having been caused prior to shipment was of this type. The other condition, which must be extremely rare, under which shot-holes could be found in teak heartwood is that at some period of its life the growing tree received a wound, such as by a neighbouring windfall, etc., which has then been attacked by one of these ambrosia beetles, the galleries of which have subsequently been occluded and absorbed into the heartwood. In no case, however, was I able in either mill to find any examples of such shot-holes.

7. *Action Recommended.*—Though I do not consider that the actual damage to the teak timber is of any great intrinsic importance, the damage to the reputation of Burma teak is likely to be extremely serious unless the fears of the people at Home are at once alleviated. I do not consider that it is necessary to abandon the use of bamboo as ship's dunnage, and I very strongly deprecate the proposed use of junglewood brushwood in its place. I consider this practice most dangerous, and it would not be possible, without a long investigation, to say that no potentially destructive insect was being introduced with this dunnage. As demonstrated at the meeting of 7th November this brushwood in its at present extremely green state already shows signs of attack by species of *Xyleborus*. Much of the older stock is riddled by various species of *Bostrychidæ* and, on principle, the use of these mixed woods as dunnage is likely to be much more dangerous than the continued use of bamboo. One round trip without bamboo dunnage, which I understand, takes about three months, should be ample to clear the hold of any living *Dinoderus* and thereafter there appears to be no reason why bamboo dunnage should not again be taken aboard, provided that it is clean. I saw new bamboo dunnage coming on to the " Amarapoora " during my visit and was able to demonstrate to the ship's officers and to Mr. Mathew that this was already attacked. I inspected the stock of bamboo dunnage in one of Captain Rushall's godowns. This was also already attacked. All this dunnage had been brought into Rangoon by rail. It is said to be loaded at Tawa in the Pegu District. *Dinoderus* finds freshly cut bamboo extremely attractive and there is little doubt that this

bamboo was attacked before it reached Rangoon. I understand that it is only of recent years that bamboo dunnage has been brought to Rangoon by rail. In the past it all came by water and at present much still comes by water. A parcel of such water-borne bamboo was produced by Captain Rushall and, as expected, was found to be quite clean and free from borer. It is well-known to all junglemen that bamboo which has been soaked in water is far less susceptible to, if not wholly immune, from attack by *Dinoderus*, the supposed reason being that the soaking in water leaches out some constituent of the bamboo which is attractive to the beetle. I have at present no definite information as to the period of submersion considered necessary to render the bamboo unattractive, but a report from Dehra Dun on file in the Timber Research Division states that soaking for 14 days results in " the danger of bamboos being attacked being greatly reduced ". It is proposed to carry out an experiment here to obtain more definite information on this point. In the meantime, however, it may be accepted that submersion for some such period will not only kill any existing borers in the bamboo, but will render it, when subsequently taken out and dried, considerably less liable to attack.

I recommend therefore that ships, having been cleared of their existing population of *Dinoderus*, should be re-dunnaged with water-borne bamboo. This would, probably in any case be clean, but should of course be inspected before shipment and rejected if not clean. Now that shipping companies and stevedores know the danger of infested bamboo, steps should be taken to ensure by previous inspection that only clean dunnage is taken aboard.

LEGUMINOSAE AND ROOT-NODULES.

By R. N. Parker, I. F. S.

In the *Indian Forester* for July, 1932, I mentioned incidentally that the failure of several exotic leguminous trees in Dehra Dun has been suspected to be due to the absence of a suitable strain of root-nodule bacteria. The evidence for this has gradually accumulated

and before describing some experiments made to test it some of the instances leading to the supposition that bacteria are involved may be given.

Albizzia fastigiata.—Seed obtained from the S. African Forest Department was sown in November, 1927, and germinated very well the following March. A year later the seedings which had been transferred to separate pots were all in very poor condition. Having started well, they gradually deteriorated. Climate did not seem to be the cause as no season of the year appeared to suit them. Absence of suitable bacteria was suspected and about a dozen plants were re-potted in soil containing an imported strain of bacteria from the Philippines suitable for *Leucaena glauca* and another dozen were re-potted in soil taken from beneath a tree of *Albizzia lebbek.* This had no apparent effect. In July, 1929, one plant started to improve and appeared to be growing well. It was, therefore, planted in the ground. Subsequently two more took a turn for the better and they also were planted out. All the remaining plants died but these three are still doing well and look quite healthy three years after planting.

Ormocarpum trichocarpum.—Two plants in pots were obtained from Delhi and planted in the Arboretum. One did not thrive and died a year or two later. The second plant, only some 30 feet from the first, has grown well. Seed from it was sown in March 1928, and many plants were raised. The dead plant was replaced and a group of about 7 plants was planted in another place. For some two years nothing amiss was evident but since then further growth has more or less stopped and these locally raised plants are obviously not doing well. At the time our imported plant is flowering most of the locally raised plants are more or less leafless.

Mundulea suberosa.—Seed from the Northern Transvaal was sown on 8th July 1931, and germinated freely on 20th July 1931. In about one month's time the seedlings began to look unhealthy and started dying off. Excessive moisture owing to the monsoon was suspected but as the plants failed to improve when dry weather set in the absence of suitable bacteria seemed probable. They were inoculated with a bacterial strain suitable for *Erythrina caffra.* The

improvement has not been spectacular but the plants when inoculated were in a very bad state and in the ordinary course could not have been expected to live. Three plants eventually improved, two being planted in the ground and the other was kept in a pot for further observation. This plant showed root nodules in September 1932, and appeared to be growing well.

Erythrina fusca.—This was tried in 1926 but the plants did not survive the winter, the failure being attributed to cold. Seed was sown again on 25th August 1931, and germinated in September. In the following spring the plants looked unhealthy and injury from winter cold appeared to be insufficient to account for their condition. In April three plants were potted in soil containing the bacterial strain from *Erythrina caffra* and four plants were potted in soil containing bacteria from *Casuarina*. The former appeared to benefit in about a month and five months later showed abundant root-nodules. The four plants in *Casuarina* soil showed little result at first, then one plant improved and five months after inoculation showed abundant root-nodules. A second plant at this time showed signs of improvement but no root-nodules. These plants have probably been accidentally infected.

Erythrina caffra.—The growth of *Erythrina caffra* in Dehra Dun does not appear to be satisfactory. The tree is widely distributed in Africa and grows under varying conditions. When tried in Dehra Dun in 1922 the plants mostly died off though one is still living and has flowered but it is far from vigorous. A few years ago there was a specimen planted as a road-side tree but it was far from ornamental, half the branches being dead and fresh branches being produced which soon died off again. Two pots of *E. caffra* seed were sown in January 1931, and in one a match-box full of soil obtained from beneath a tree of *E. caffra* in Durban was mixed with the soil in the pot, in the other local soil was used. By the time growth ceased in the autumn the inoculated plants appeared to be better than the controls but comparison was difficult to make fairly owing to irregularity in germination making the plants appreciably different in age. All the inoculated plants showed abundant root-nodules

whereas the controls showed none. After the winter the inoculated plants began to outstrip the controls. Some of each were planted out and by August there was no doubt whatever that the plants with nodules were better than those without.

Experiments were started in April last to see if the failure of certain exotic leguminous plants is due to the absence of a suitable strain of bacteria and secondly to see if the *Casuarina* strain is or is not the same as one of the leguminous strains. Several difficulties arise the chief of which is to prevent accidental infection. If, as I believe is the case, the poor results obtained with *Albizzia fastigiata* is due to lack of a suitable strain of bacteria it is obvious that accidental infections occur with no known source of origin. Consequently with numerous sources of supply of bacteria close at hand accidental infections are likely to be much more frequent. In the experiments recently made such accidental infections seem to have been so frequent that they take away much of the value of the results. Plants with and without nodules are being planted for further observation but one is far from certain that the plants showing no nodules are free from infection. It is quite possible that they will later develop nodules in which case both sets of plants should grow equally well. In a short time we are likely to have most if not all the tropical strains of leguminous root bacteria and any difficulty in growing leguminous plants will not be due to the absence of appropriate bacteria. We have received plants in pots from Calcutta, Lucknow, Saharanpur, Lahore, Delhi and Bangalore, any of which may have brought strains of bacteria not found locally. Gardens in the above named places have for years exchanged plants so that the bacteria they now possess doubtless include many exotic strains. It may, therefore, be of interest for the future to note some additional species which from their unsatisfactory or irregular growth are suspected to require a special strain of root-bacteria.

Albizzia saponaria.—This was tried two years ago; it started well but soon began to deteriorate. Six plants all in a miserable condition were left last April. Three were potted in soil containing the *Erythrina caffra* strain of bacteria and three in soil containing the

Casuarina strain. Our local potting soil was used. One of the former lot in *Erythrina* soil rapidly improved and five months later showed numerous nodules but of quite a different type to those of *E. caffra*. The nodules were small pearly white and found on roots near the surface, none being seen on roots reaching the sides of the flower pot. The other two plants died. At this time one of the plants in the *Casuarina* soil showed improvement but no nodules could be seen even when the roots were washed clean. No safe conclusions can be drawn from this experiment but it seems probable that some strain different to *Casuarina*, *Erythrina* or any local strain is involved.

Bauhinia hookeri.—Some plants are growing moderately well, others have remained alive for years making hardly any growth.

Bauhinia galpinii—Our first plant of this species was grown in a former potting shed about four miles from our present one. It flowers freely and is highly ornamental so that there is a demand for plants which we are not able to meet. Locally grown seedlings are very weak and usually die off. In my garden I had two plants one a locally raised plant and the other a plant imported from Delhi. The local plant is in miserable condition and refuses to grow, it sends out a succession of shoots with very small leaves but the shoots soon lose vigor and die off to be replaced by others that do the same. The Delhi plant is very much better with much larger leaves and has flowered. Local seed sown in soil containing various strains of bacteria including *E. caffra* germinated in all cases but no plant lived more than five months. This year seed obtained from the Northern Transvaal was sown and the seedlings as soon as they germinated looked far more vigorous than seedlings from local seed, the cotyledons being markedly bigger. After producing about two leaves these seedlings ceased growth and gradually turned yellow. They were watered with a suspension of bacteria from a *Casuarina* root-nodule with no visible result. Three weeks later they were watered with a suspension of bacteria from a nodule of *E. caffra*. A week after this the nerves of the leaves had turned a deep green and contrasted strongly with the yellow of the rest of the leaves. In another week the leaves were a normal green all over and growth recommenced and

has been satisfactory ever since. No nodules could be found on the plants in October even when the roots were washed clean. In this case we unfortunately had only one pot of seedlings so that no controls could be kept.

Erythrina abyssinica, bogotensis, insignis, lithosperma, vespertilio and *viarum* have all been tried with very unsatisfactory results. In some cases cold in winter may be responsible for the failure but lack of suitable bacteria may have been a contributory cause. One plant of *E. abyssinica* one year old which showed no root-nodules was inoculated in April 1932, with bacteria from *E. caffra*. Upto July no nodules were visible but in August they were abundant.

In April 1932, seed of the following species was sown :—

Albizzia katangensis, Bauhinia galpinii, Casuarina cunninghamiana, Erythrina vespertilio, Mundulea suberosa and *Ormocarpum trichocarpum*. Each species was sown in six eight-inch flower pots thus giving six groups of six species. In one group soil from a pot containing a plant of *E. caffra* which showed abundant root-nodules was mixed with the soil used in the pots. In a second group soil taken from under our only good specimen of *Ormocarpum trichocarpum* was used in the same manner. In a third group soil known to contain the *Casuarina* strain of root-bacteria was mixed with the soil used for the pots. Two groups were used as controls. The pots used were new and soil from a nursery belonging to the Forest Entomologist was employed instead of our own potting soil. The *Albizzia* failed to germinate. The *Bauhinia* germinated in all pots but gradually died and no plants were left in September. Plants were examined from time to time by turning the ball of earth out of the pot and looking for nodules on the exposed roots. In doing this it is obviously essential not to handle pots belonging to different groups. Owing to the risk of accidental infection efforts were made to terminate the experiment as soon as possible but it was over four months before nodules were sufficiently obvious on *Ormocarpum* and fully five months before *Mundulea* showed them.

The results are as follows:—

Ormocarpum trichocarpum.—In soil infected with *Erythrina caffra* strain 17 plants all showing nodules. In soil from under a specimen of *Ormocarpum trichocarpum* two plants showed nodules, eight showed none. In soil infected with *Casuarina* strain five plants showed nodules, six showed none. Controls—first group—two showed nodules, ten showed none. Controls—second group—three showed nodules six showed none.

Mundulea suberosa.

Erythrina caffra soil: five with nodules, three without.

Ormocarpum soil: three with nodules, five without.

Casuarina soil: two with nodules, 12 without, eight in very poor condition or actually dead.

Control—first group—three without nodules, five poor or dead.

Control—second group—three without nodules, seven poor or dead.

The *Erythrina vespertilio* germinated poorly and there were too few plants in any group to give results of value. No nodules were visible until October. The *Casuarina* germinated well but upto October no nodules could be found and even then only one was found, a very small one, after many plants had been examined by washing the roots clean. Six months was evidently not a sufficiently long period for this experiment. The *Casuarina* had been grown in soil known to contain the appropriate bacteria and the seedlings in addition had been watered with a suspension of bacteria obtained from a nodule on *Casuarina glauca*. One of the coolies working in the garden in an excess of zeal filled up all the pots, both controls and others, with ordinary potting soil known to be more or less contaminated so that it was useless prolonging the experiment.

Results.—In considering the results the pots filled with soil from under a good specimen of *Ormocarpum* are best neglected. In previous work with *Leucaena* and *Erythrina caffra*, soil containing suitable bacteria did not give convincing results in the first year. In both cases a second year was necessary before the results were beyond doubt. The strain of bacteria that forms root-nodules on *Erythrina*

caffra seems to be the same as the one that produces root-nodules on *Ormocarpum trichocarpum* but the accidental infections have been high. It is I believe also the same strain that produces nodules on *Mundulea suberosa.* Plants of this species inoculated with *Erythrina caffra* root-bacteria were markedly better than those inoculated with *Casuarina* root-bacteria and contained no dead or dying plants. Here again accidental infections seem to be very numerous as all except the plants recorded as "poor or dead" are probably infected. The *Casuarina* root organism seems to be a different strain to this leguminous strain.

Possible source of accidental infection.—In the experiments described above the pots were all watered from a tank filled with canal water and if this tank has become contaminated as could easily happen it would account for all the accidental infections that appear to have occurred. In the hot weather after the pots have been watered it is common to see them visited by numerous hornets, wasps and other insects that settle on the damp soil to obtain water and also perhaps to try and cool themselves. These insects could easily carry bacteria from one set of pots to another.

FOMES ANNOSUS ON DEODAR.

By K. L. Aggarwal, I. F. S.

Introduction.—Fomes annosus is probably the most important fungus disease which threatens some of the deodar plantations and regeneration areas in the Kulu Sub-Division. Originally according the Kulu Working Plan it was noticed in the plantation (dating back to 1900) in R/7 Takrasi C. II. of the Outer Seraj Range in the Seraj Forest Division. The area is rather damp for deodar being more suited to spruce of which the original crop mainly consisted. Subsequently spruce was, unfortunately, girdled to a large extent and deodar introduced on an extensive scale. This operation, it is feared, had an adverse effect as the fungus is more virulent in pure deodar plantations than in mixed crops. The fungus had from time to time

killed out many poles from the old plantation and young saplings can also be seen being killed off here and there outside this plantation in the rest of the area under regeneration. There is little doubt that the fungus is now fairly general over the whole plantation though the damage outside the old plantation so far is not extensive. The affected pole assumes a sickly appearance, the crown gets attenuated, the needles turn pale and there is exudation of resin on the stem. When uprooted the roots are found rotten and spongy and are covered with the white mycelium. Of late the fungus has been observed to be steadily spreading and is now seen attacking many other regeneration areas. Unfortunately, so far no sure remedy to wipe out the disease or check its further growth has been found.

A detailed account of the fungus and its mode of attack on the deodar is described in an article by Mr. Butler published as an appendix to the *Indian Forester* for November 1903. That the treatment of this disease is very difficult was foreseen and in this connection an extract from this article may be quoted :—" Even when the roots of adjacent trees do not come into contact, the rhizomorph can bridge over a space of probably many inches to spread the disease. The large quantity of rhizomorphs found on the deodar shows that these must form the chief mode of propagation in India and the discovery of these organs indicates a greater capacity for damage than in any other instance in which this fungus is known as a forest pest. Hence the treatment is not hopeful. The rhizomorphs cannot readily be destroyed. Isolation of diseased trees by trenching is the only method likely to be successful. Such a treatment is advocated in Germany but it appears to be doubtful if it can carried out profitably on a large scale. The removal of sporophores from the stem is probably a measure of quite secondary importance."

The only remedial measure suggested by Dehra Dun was to dig an isolation trench $2' \times 2'$. Drainage by means of trenches was also suggested but the area is already well drained.

Experiments carried out and their results.—This article deals briefly with the experiment of an isolation trench and the results so far

obtained :—

In 1921-22 two acres of the plantation were isolated by a trench 9″—1′ deep to check the spread of the fungus but the experiment proved unsuccessful and it was thought to be due to the trench not being sufficiently deep. In 1927-28, therefore, a trench 3′ deep 3′ wide and 840′ long was dug out isolating 3½ acres at a cost of Rs. 31/7/- with a view to study its effect in preventing the further spread of the disease. In 1928-29 Rs. 30/- were spent to clear the trench and Rs. 7/12/- and Rs. 19/9/- were again spent during 1929-30 and 1930-31 respectively. The results of the observations are given below :—

Year.	Mortality outside the experimental plot over 24 acres.	Mortality inside the plot over 3½ acres.
1928-29 ..	400 *i. e.* 17 per acre.	14 *i. e.* 4 per acre.
1929-30	198 ,, 8 ,, ,,	12 ,, 3½ ,, ,,
1930-31 ..	182 ,, 7½ ,, ,,	9 ,, 2½ ,, ,,

These results show that although the mortality amongst the poles inside the trench was less than the mortality outside yet the very fact that it had failed to prevent the disease from spreading to the trenched area would show that the method could hardly be relied upon as a satisfactory remedy besides being far too expensive—the total expense on the up-keep of the trench from 1927-28 to 1930-31 had been Rs. 88/12/- over 3½ acres, *i. e.* a little over Rs. 25/- per acre. Thus the expenditure involved is so great as to make the method of little practical value even if it was at all satisfactory. It is further very likely that comparative immunity may be due to the poles having attained sufficient size to resist the disease. The second practice was to uproot and burn the roots of the infected trees. It is not possible to say what beneficial effect this had but in my opinion it was worse than useless because not only was it impossible to dig out all the affected roots but on the other hand the spores and mycelium were sure to be further spread on exposure. This was therefore stopped in 1930.

Conclusions.—The facts that the general condition of the plantation is on the whole fairly good and that its value has been enormously increased by cultural operations should dispel all fears. Although the plantation contains gaps here and there caused by the death of the diseased trees the number of casualties amongst the poles seems to be falling off and it appears that with advancing age *the poles are recovering from the attack. It appears that in the* struggle between the deodar and the fungus although a number of plants are killed the remaining healthy poles outgrow the danger in the course of time and the survivors form a sufficiently canopied crop mixed with natural spruce.

Another point which may here be stressed and which has already been alluded to above is that the fungus is worst in localities which are not very suited to deodar. The Takrasi forest as already noted is rather damp. On the other hand the fungus is also noticeable to an appreciable degree in 1/21 Solono regeneration area which is too dry. There seems little doubt that the damage is greater in areas where the deodar is growing under unfavourable circumstances either on account of the locality being too damp as in R/7 Takrasi or too dry as in 1/21 Solono.

The remedy therefore lies in growing each species in the locality best suited to it and in maintaining a judicious mixture. In the Takrasi plantation we are now introducing walnut in some of the gaps created by the fungus while the others are being allowed to fill up naturally with *kail* and fir.

EXTRACTS.

POLLARDING IN THE CONTROL OF SANDAL SPIKE.

By M. Sreenivasaya.

(Paper presented before the Society of Biological Chemists, India, on 21st December 1932).

Eradication of the sources of infection forms an essential part in the control of infectious diseases of plants. In the case of sandal spike, the diseased plant is a known source of infection endangering the health of the other sandal plants. Yet another source of infection recently shown to exist is the disease-masking sandal, whose detection and removal are necessary to ensure a more effective control of the disease.

These plants do not show any striking characteristics which differentiate them from those which are entirely free from infection ; their detection by casual observation is a difficult and uncertain task. At the moment the only available method by which we can diagnose such plants is pollarding, which usually forces out symptoms of disease from a suspected plant with the growth of the new flush (*Nature*, 1930, 126, 957). This technique has proved extremely useful in obtaining quick and decisive results with plants subjected to artificial disease transmission. Without pollarding, the successful grafts take a comparatively longer time to induce the disease on the stock, while pollarding shortens the period to about a tenth or more. Comparative experiments to determine the effect of pollarding on the incubation period elapsing between infection and spiking) have been conducted.

TABLE I.

Pollarded series.

	1	2	3	4	5	6
Date of grafting ..	11-7-32	18-7-32	13-7-32	13-7-32	14-7-32	14-7-32
Date of spiking ..	29-8-32	30-8-32	30-8-32	2-9-32	30-8-32	6-9-32
Incubation period in days ..	49	48	48	50	47	54

Those that have not been grafted and not pollarded as controls to the above series are still continuing healthy for 173 days. The plants have put on growth both in height and girth during this period. If left undisturbed the plant would take nearly two years and a quarter to exhibit the symptoms of disease ; in a few cases, the period has been found to be very much longer depending upon its age and size and the character of the host associated with it.

Pollarding has been adopted on an extensive scale under silvicultural conditions with two objects in view ; (1) to detect the disease-masking sandal plants in an infected area and (2) to determine if any such plants exist in a healthy area with a view to their early eradication. In the case of an infected area, the operation is

carried out on sandal plants situated around the site of primary attack. The acreage brought under operation depends roughly upon the extent to which the disease has visibly spread. A few groups of sandal plants around the reserve, in the area intervening between the affected forest and other diseased areas may also be pollarded to determine, if possible, the continuity and spread of disease. In the case of a healthy area, a few sandal plants chosen at random and distributed throughout the suspected area are pollarded. The results are tabulated in Table II.

TABLE II.

Area.	No. of trees pollarded.	No. of trees spiked.	Percentage.
Manchi A.	307	9	2·9
Manchi B.	8,333	510	6·1
Kempagere	354	7	1·9
Galigattam	8,877	271	3·0
Jawalagiri (6-acre plot)	75	2	2·6
Nyamasandiram	50	5	10·0
Sanamavu	44	0	0·0
Thalli R. F.	54	0	0·0
Uduparani	42	0	0·0

Several objections have been raised with regard to this operation being enforced on an extensive scale in affected forest areas. Among the more pertinent may be mentioned: (1) the trees are rendered more susceptible to disease by the operation of pollarding ; (2) pollarding arrests the growth of the sandal plant, and (3) the plant, if left undisturbed, would probably have recovered and meanwhile grown in girth and height.

The first objection is not supported by experimental facts and field observations. Grafting of pollarded plants under controlled conditions has not yielded a higher percentage of incidence and those pollarded in the Jawalagiri 6-acre regeneration plot have not succumbed to the disease although quite a number of other undisturbed plants have taken the disease. Similarly in the Thalli R. F., where pollarding has been conducted, none of the operated plants have become spiked although the natural infection has spread to other intervening sandal plants. The second objection is no doubt true, but the growth is arrested only temporarily for a season or two. It is very difficult to meet the third argument, but there is experimental evidence to show that timely decapitation of branches with infection localised in them, will save the trees from spiking ; and to this extent pollarding is a possible advantage. It is true that a disease-masking plant does put on growth but its presence as a source of infection has to be first considered and dealt with accordingly.

The efficiency of pollarding as a measure of disease control should be recognised, but the one serious drawback of the method as it is practised to-day is that the percentage of plants which suffer pollarding in proportion to those which show the symptoms is extremely high. In the case of Galigattam (Table II) for example about 8,600 plants to the extent of 97 per cent. have been unnecessarily interfered with. At the present stage of our knowledge this is a necessary evil which cannot be avoided.

With experience and observation, we shall soon be able to restrict the operation to a smaller number of trees in an affected area. Observations and tests are now in progress with a view to developing a field method of diagnosing these disease-masking plants, which, if successful, would not only reduce the cost of the operation but also enhance the value of the technique a hundredfold.

WATER STORAGE IN FOREST SOILS.

While most persons with perception can understand in a moderate way what the denuding of vast areas of forest land has done to deplete soil storage of water and to stimulate the rapid runoff of rain and snow, there is a natural question in the minds of many persons surrounding the totals that are involved.

A recent experiment by the United States Forest Service, therefore, will be revealing. The bureau carried on a test of the usefulness of forests as "natural reservoirs" for feeding underground water supplies and regulating rainfall runoff and stream flow. In this study it was shown that virgin forest soil at a depth of one inch absorbed forty-six times as much water per minute as soil at the same depth in adjacent fields.

And to appreciate this in its proper degree, it must be remembered that water that falls or snow that melts either runs off promptly, seeking the streams to the seas and escaping useful service in the area of its precipitation, or seeps into the ground for the use of nature as and when needed. So at a ratio of 46 to 1 in favour of the storage facilities of wooded land, there is small wonder that we have flooded streams when the rains descend on a bone-dry countryside when we need the moisture. While we have understood the advantage of timberland storage, we have not understood sufficiently.—(*St. Louis Globe-Democrat*).

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FORESTS AND RIVER CONTROL.

In our March number we published as an extract a review from *Nature* of a paper presented to the American Society of Civil Engineers entitled "Forests and Stream Flow." In this the authors, Messrs. Hoyt and Troxall, have produced statistics for a mountain catchment area showing the effect of disforestation upon the quantity of water discharged from the area, and *Nature* registers surprise over the results which do not bear out the time-honoured theory that a continuous forest canopy must indubitably ensure the largest minimum yield of useful water. In view of the vast commitments of Government money sunk in irrigation canals and hydro-electric schemes in various parts of India, the prosperity of which is based upon a regular and unfailing supply of water, it is essential to keep this necessity clearly before us. Water has become the product of highest value from our mountain catchment areas and the management of such areas should therefore have for its object the maximum beneficial yield of water. To achieve this there are two lines of attack: firstly, salvage of local flood waters and secondly, reduction of the losses from evaporation and transpiration of moisture from the catchment area surface. The first is infinitely the more important, but some of us are apt to be sidetracked into the mazes of scientific speculation over the second.

For the salvage of local flood waters we have to aim at the collection and regular distribution of as much as possible of the available water. Part of this occurs in the form of surface run-off and part from underground supplies, and there is a growing mass of accurate scientific data to prove that some form of forest canopy or thick mat of vegetation is the most efficient means of ensuring the efficient tapping of both these sources. The importance of such a soil cover lies not so much

in its capacity to absorb water as in the way it protects the soil itself from erosion. Recent measurements in America by C. L. Forsling (1), and Rockie and McGrew (2), and in Burma by Warth (3), have confirmed the classic Swiss experiments of the Emmenthal and many other older observations of the destruction which follows in the wake of erosion. As long as the natural soil profile is protected by the vegetation which best suits the locality, it continues to yield a regular run-off, but whenever this cover is interfered with by heavy grazing, fire, or erosion,—or as so often happens in India, a disastrous combination of all three,—the soil profile is radically altered and striking differences in the run-off are bound to occur. Forsling's experiments in Utah do not set out to compare forest with non-forest covers but they show clearly that the increase in the density of the vegetation from 16 to 40 per cent. of a complete cover, and the replacement of certain plants by others with more extensive and more fibrous root systems, reduced the rainfall surface run-off 64 per cent. and rainfall erosion 54 per cent. Lowdermilk's experiments (4) in California show that the surficial run-off from burnt and bare surfaces exceeds that from litter-covered surfaces by 3 to 30 fold and erosion by 50 to 6,000 fold and that forest litter continues to function in this respect far beyond its complete saturation with water under an artificial monsoon of 80 inches of rainfall in 23 days. Both of these results emphasise the importance of any good vegetational cover in reducing floods and controlling erosion and the need for the strictest regulation of grazing, which so rapidly destroys this cover on slopes subject to torrential rainfall.

The position has been very ably summarised by Raphael Zon (5) in his book which is generally recognised as the most authoritative of the many publications on this subject :—

" In level country, where there is no surface run-off, forests in common with other vegetation, act as drainers of the soil ; hence their importance in draining marshy and improving hygienic conditions. In such country their effect upon springs is unimportant.

In hilly and mountainous country forests are conservers of water for stream flow. Even on the steepest slopes they create conditions

with regard to surface run-off such as obtain in a level country. Irrespective of species, they save a greater amount of precipitation for stream flow than does any other vegetable cover similarly situated. They increase underground storage of water to a larger extent than do any other vegetable cover or bare surfaces. The steeper the slope the less permeable the soil, and the heavier the precipitation the greater is this effect.

In the mountains, the forests, by breaking the violence of rain, retarding the melting of snow, increasing the absorptive capacity of the soil cover, increase underground seepage, and so tend to maintain a steady flow of water in streams."

As regards the much less important question of the possible reduction from evaporation and transpiration losses from catchment area surfaces, several recent investigations such as Hoyt and Troxall's mentioned in the first paragraph, Nicholson's in Kenya (6) and Benskin's in Chota Nagpur (7), Hirata's in Japan (8) and the well-known Wagonwheel Gap investigation by Bates and Henry in Colorado (9) all go to prove that one cannot afford to be dogmatic about the effect of a forest canopy as opposed to a lower canopy of grass and herbs in bringing more rain or in reducing evaporation. In the American and Japanese experiments the effect of "denudation" of forest areas was carefully measured and it was found that the difference in comparative run-off reflected fairly accurately the state of the canopy. These were all mountain areas with a well-distributed rain and snowfall where a rapid regrowth of aspen or other shrubs *unaffected by grazing* reclothed the whole of the denuded area within three years—a very different interpretation of the word "denudation" than would be given by any Indian forester, who would naturally envisage the complete destruction by fire and over-grazing of any regrowth which comes up to replace the felled trees. Even under favourable circumstances, the erosion ratio in the Wagonwheel Gap experiment increased from 0·822 to 7·002 *i.e.* 8½ times as high, after this very temporary denudation. In face of such figures the question of how much comparative evaporation goes on from forest or grass land canopy does not appear to be of very great importance, particularly as the factors

such as underground drainage and artesian water action make it well nigh impossible to get absolutely reliable data. After all, it is the subsoil, not the vegetational covering, which is the principal absorbent of the rainfall, and the point we wish to emphasise is that rather than decry the value of forests in water control, because they are in certain places not so very much better than good grass cover, let us insist upon the imperative need for maintaining some mantle of vegetation which will be an effective cover against the erosion which is rapidly ruining the forest grazing grounds of India.

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THE KAREN STOCKADE METHOD OF CAPTURING WILD ELEPHANTS.

BY J. A. CLARKE, I. F. S.

There are two distinct methods employed in Burma for capturing wild elephants namely the *mela shikar* and the Karen stockade method. The *mela shikar* method is not commonly used ; in this highly trained elephants are sent with men on their backs into a herd, selecting a good beast, noosing it and dragging it to captivity by means of the two trained elephants.

Before entering into a detailed description of the Karen stockade method of capturing wild elephants, it is necessary to mention the principles involved. A wooden stockade is built to hold from 40—50 elephants, closed on three sides with a drop door on the fourth so that it can be securely closed when the elephants are caught. Leading up to the door of the stockade two wings are built about 600 feet long or longer depending upon the nature of the country ; the stockade thereby forms the neck of a funnel. A herd of wild elephants is then driven into the stockade and the drop door is closed. The method of driving them requires skill, patience and a thorough knowledge of the habits and temperament of elephants. Before any capture can be made there is necessarily a great deal of preliminary work to be done.

Preparations.—A block of forests is let out to a *kheddah* licensee who is generally a Karen. The Karens are a very jungly race capable of living under great hardships. The license having been issued, the security deposit paid and the agreement signed, the licensee then starts collecting material. Hundreds of feet of good strong rope are required. A certain amount of manilla rope is used but by far the most popular and probably the best is made of *shaw*. *Shaw* is made from the fibres between the bark and the cambium layer of *Sterculia*. It is peeled into thin strips, dried and then twisted. When made the ropes can be easily softened by means of oil. The following is a description of the procedure as carried out in Meiktila Forest Division.

In October 1931 the *kheddah* license was issued to a Karen. Among the conditions laid down in the license the following are worthy of note :—

1. The stockade shall be constructed of posts and poles free from all bark, knots and projections which might injure elephants.

2. The number of stockades to be built is limited to two in any one year.

3. The license is in force for a period of 3 years.

4. The licensee shall maintain a sufficient number of men for the operation (the number is normally 30 to start with) and a sufficient stock of medicines both for workmen and animals after capture. Recognised country medicines are permitted.

5. The licensee shall release immediately or after such period as this can be done with safety, the following elephants :—

(*a*) Any elephant which is too old for timber work ;

(*b*) any female elephant heavy with calf when captured. Malformed or diseased elephants should be released or destroyed.

6. A closed period is prescribed during which no driving or capturing should be carried out. This period depends largely upon the nature of the forest, the ruling factors being shade, water and fodder in abundance.

7. The lease also prescribes the amounts of royalty payable on elephants when captured as follows :—

(*i*) Rs. 50/- for every elephant captured or killed during capture except calves measuring less than 4 feet 6 inches at the shoulder and such elephants as have had to be released or destroyed.

(*ii*) An additional royalty on the undermentioned scale in respect of all animals which have survived capture and training.

Height at Shoulder.	Rs.
Below 5 feet	Nil.
5′—5′-11″	50
6′—6′-11″	100
7′—7′-11″	150
8′ and up	200

Throughout the early part of 1932 the licensee had employees searching the neighbouring forests for *shaw* from which the rope was

Young elephant in a training cage two days after capture.

Front side views of stockade showing entrance, drop-gate and wings.

made. The work of building the stockade was commenced early in September 1932. The site chosen was in dense bamboo jungle not far from a running stream. The dimensions of the stockade were as follows :—60 feet long, 6 feet wide at the closed end and 12 feet wide at the open end or gate end. Two wings were built out from the stockade approximately 600 feet long, the extreme ends of which were 500—600 feet apart. Stout poles and posts were used for this work and were buried about 2 feet into the ground and naturally available trees were also used. The whole structure was tightly bound together with manilla rope and bamboo knees. The stockade was very strongly built in order that it would be able to bear the brunt of the elephants' wrath immediately after their capture. The sides of the stockade were built some 18—20 feet high securely fastened at the top with cross stays. All rough bark and branch knots were removed and smoothed over so as to minimize the dangers of captured elephants being wounded. The gate at the entrance to the stockade was built of strong timber and to prevent any possibility of weakness, it was so constructed that it would slide down between two stout poles on each side of the gate. The bottom of the poles forming the main part of the gate were sharpened to a point so that when dropped they would be imbedded securely into the ground. A small platform was built near the gate and above the entrance to the stockade, on which the attendant would sit and be able to let the gate down at the correct moment.

After the stockade had been built, training cages were then made of strong poles round the sides of the stockade. Each training cage was capable of holding one elephant. The number depends upon the number of elephants likely to be caught. In the operations being described 14 were built. All training cages were built with a tree which would form the main base of resistance. As in the stockade, all rough bark, knots and branches were carefully removed. As the elephants would have to be in these cages for 2 or 3 days precautions were made in advance to see that means were available for keeping them clean and dry. In some cages situated on damp and low lying ground, floors of poles were made, but in others on well drained sandy soil a pile of dry sand was sufficient. In building the stockade and

training cages as little damage to the jungle as possible was done immediately in front of the wings and the stockade, all posts and poles were cut from behind. The employees' camp was 1½ miles away.

By the time preparations were almost complete, the remaining work to be done was to see that every thing to the smallest detail was ready. The stockade and wings were carefully camouflaged by branches of trees and bamboos. Two rows of lamps, ready to light, were placed on sticks, the front row was about 40 yards in front of the ends of the wings and the second row joined the ends of the wings. Ropes were placed with slip knots ready made round the outside of the stockade and lastly a *dah* or knife was hung on the platform near the gate with which the rope holding the gate up was to be cut. To neglect any of these last minute details might possibly have ruined the whole drive.

The Drive.—To drive a herd of elephants into a small enclosure several miles away from their feeding grounds is obviously no easy task. Experience, patience and an ability to put up with great hardships are essential. The work rested with 5 or 6 experienced men who by showing lights at night and making noises by day gradually moved the herd in the required direction. Too much of a display would frighten and probably stampede the herd and the drive would have to start again.

A drive may take only a few days or may take 2 or 3 weeks depending largely on the country over which they are to be driven and how the herd responds to the driving. The final drive generally takes place at night, in order that the elephants cannot see or suspect anything. During the operations being described a herd of elephants was driven about 7 miles across a main road and railway line, but either on account of the weather turning hotter, lack of food or possibly lack of caution on the part of the men during the driving, the herd turned and went back to their feeding grounds near the hills.

It was then decided to build a second stockade near to the normal feeding grounds of the herd. This took about 1 month before all the preparations were again complete. The second drive started on the

30th November 1932 but owing to the activity of an old tusker which continually charged the men driving, it was found only possible to drive a small herd, which had become detached from the main herd. This herd of 11 elephants was successfully driven into the stockade on the night of 2nd December, *i.e.*, after only 3 days. During the operations the herd was driven completely round the stockade before it could be successfully persuaded to go between the wings. Watchmen were stationed in trees at the ends of each line of lamps, and as soon as the elephants were inside the first line, they climbed down from their post and lighted the lamps. Men following behind the herd then fired guns and let off Chinese crackers and so stampeded the herd in the required direction. When the herd was inside the wings, the second line of lamps were lighted. As soon as the elephants arrived in the stockade, the gate controller by means of a long bamboo probe felt to see that the space underneath the gate was clear and being satisfied that it was, he cut the rope holding up the gate which then crashed down, completely closing the stockade.

Training.—Immediately after the elephants were caught they were separated and tied securely to the sides of the stockade so as to prevent them from damaging each other in their efforts to escape.

A large tusker is a source of great danger and in order to safeguard the remainder of the herd, one so caught has frequently to be released or destroyed. The method of tying the beasts to the stockade and separating them requires skill and experience. A rope with a slip knot already prepared is passed through the sides of the stockade and by prodding the animal's feet in turn until they are lifted off the ground, the loop of the rope is then by means of short hooked sticks slipped under the feet. Once the feet are securely fastened the elephant can be manœuvred about until it is separated from the rest. Poles are then placed across the stockade as an additional precaution. When all the captured animals were securely fastened the stockade was partially dismantled and each elephant was taken out separately and tied in a training cage. This was by no means an easy task, and required skill and patience to force the animal to go in the required direction.

When securely fastened inside the training cages, two poles were placed under the belly of each animal in order to prevent them from struggling to break loose. Two attendants were told off to look after each elephant. They had always to be at its side, hand feeding it with bamboo leaves, giving it water to drink and generally making a fuss of the elephant, so that it would quickly get used to seeing human beings and learn not to be afraid of them. The attendants had also to sleep near their elephant at night. After 2 or 3 days in the training cages, depending as to how they were submitting to capture, the elephants were then taken from the cages and tied to trees. They had then more freedom of movement, the ropes on the front feet had been replaced by cane shackles, although they still had ropes tied above the knee. Any attempt on the part of an elephant to break the ropes was promptly checked by the attendants who went to the animals head and gave a sharp command ; and only in extreme cases was force necessary.

The elephants were moved to fresh stands every other day so that after 3 or 4 such moves, they quickly learned to do what was wanted. Within a week of their capture the attendants were able to feed the elephants with jaggery and bananas and to approach quite close to them without the elephants showing any signs of fear. It is surprising how quickly these large animals answered to their training. Less than 5 weeks after their capture they were permitted to wander about the jungle with only shackles on their feet and a long rope trailing behind.

The attendants at first were always with them, and had any attempts been made to escape, the elephants could easily have been tied to a tree by means of the long rope. About the same time the elephants were taken to water and bathe in the stream with only a small rope tied round their necks and with no shackles on their feet. When the elephants have arrived in this stage and when they no longer fear man, their training can then start in earnest, until after 6 months from their capture they will be sufficiently trained to start timber work or to be used as baggage animals.

UNDERPLANTING IN TEAK PLANTATIONS.

BY H. G. CHAMPION, I. F. S.

The systematic work carried out in the Dutch East Indies in investigating the many problems connected with teak plantations continues to bear fruit. Some of it has been surveyed in its Indian application in my recent publication on 'the pure teak problem', and a very recent article by Dr. Eidmann is so interesting as to justify the reproduction of an almost literal translation of the German summary. Our Indian experience with underplanting has not been very successful and we shall mostly not greatly regret this demonstration of its futility under another set of conditions.* It will be noted that the underplanting as a purely silvicultural operation was very successfully effected, thanks to the heavy opening up of the 12-year-old plantation, and undoubtedly to good planting work also. Whilst realising that a different degree of opening up the teak canopy or a different age for the teak plantation, may lead to very different conclusions even in the same locality, this demonstration for a quite typical set of conditions is most instructive. On reading accounts of work in Java, one wonders why more systematic trials are not made with *Leucaena* in India. This shrub seems to require a special organism in the soil to flourish, apparently an organism rare in agricultural soils such as we have at the Research Institute, but judging from Java it should develop at once in any *taungya*.

Translation of the summary of a paper by Dr. F. E. Eidmann in Tectona, XXV, (12) 1932, pp. 1675-1682.

1. The idea of introducing 'junglewood' species into teak plantations in the Dutch East Indies dates back to 1893 (van der Haas). Real underplanting was first proposed in 1908 by Claasen and v. Deventer, the latter recommending it primarily as a fire protection measure.

2. Beekman included underplanting in his investigations on the mixture of teak with other species and laid out eight series of plots with 60 plots in all in 1915-18.

* Rainfall averages 110″ well distributed with 107 rainy days with only July, August and September having less than 4″ during the month.

3. After short notes on the Java underplanting experiments by Noltée and British Indian work by Altona, the first publication to deal exclusively with underplanting appeared in 1928, when I. v. Roosendael described an investigation with 23 species in 36 plots which he had laid out on good soil in 1926. Only 2 of the 23 species, *Swietenia macrophylla* and *Derris microphylla* still persist and they have not developed enough to justify a detailed comparison of growth and yield with the adjoining plantations which were not underplanted.

4. A second series of experiments, likewise laid out in 1926 by I. v. Roosendael, to determine the effect of a dense invasive undergrowth of *Lantana* on the growth of the teak already presents very definite results. The *Lantana* is a shallow rooted weed higher than a man, which has spread all through the teak forests. v. Roosendael laid out in an extensive teak area with thick *Lantana* undergrowth, eight scattered pairs of plots, the *Lantana* being uprooted in one of each pair, the other forming the control. The measurements taken in 1926, 1930 and 1932 demonstrate that the basal area increment for the period 1926-30, averages 33 per cent. more in the cleared plots and for 1930-32, 31·6 per cent. more, *i.e.*, the same superiority was maintained. This corresponds to an increment of about 29 cubic feet per acre per year which covers clearing costs with an ample margin. The *Lantana* also reduces the height growth, for by 1932, in every pair the weeded plot was higher, the average lead being 3·8 per cent.

5. The experiments laid out by Beekman demonstrated for the poor soils of Tanggoeng, etc., were first worked up by Hart in 1929. The data shewed conclusively that the attempt to improve the soil conditions and the overwood by underplanting had failed. Only in one series did it check the dying off of the overwood and even here it was not the effect of the underplanting but of the soil working and consequent better drainage. The result of these experiments can be taken as definite proof that other lines than underplanting must be looked to for improvement of this type of soil.

6. Beekman's plots on good soils were also worked up by Hart and the results have recently been published by him. He reaches

the conclusion from the extensive series of experiments at Margasari that no improvement of the overwood can be shewn to result from underplanting although the work was quite successful ; the operation is thus purposeless as well as expensive. Hart's methods and his studies of the comparability of soil quality over the experimental area, the height growth in the plots and the surround, the effect of interplanting *Leucaena*, and the effect of the underwood on the branchiness of the teak, have all been rejected by the present author. Re-examination of the data leads to the following deductions :—

The Margasari investigation consists of two parallel sets each of eight plots on level ground on both sides of a road. The arrangement of the plots is

H G F E
A B C D
―――――
D C B A
E F G H

A third set of eight plots was taken without underplanting. The teak overwood is now 27 years old and the underplanting 15 years. When the experiment was begun in 1917 only one-tenth of the overwood was retained* and this heavy opening out reduces the value of the investigation in that it is difficult to distinguish its effects from those of the underplanting. The initial height measurements demonstrated the absence of significant variation in soil quality over the experimental area apart from petty exceptions which could be excluded. The effect of the underplanting on the height growth is now obvious, varying greatly with the species. The agreement between the two series is very close. Diameter or basal area increment might be expected to show more marked differences even than the height growth. Hart only studied the latter. In both series *Antidesma bunius* has checked growth least and *Swietenia macrophylla* most. In the period 1918-23 when the underwood was small and so could not have made much difference 'there was already a difference of 25 per cent. between the two extremes as measured by basal area increment of the overwood' and this difference became much more

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* At 27 years of age, there are now roughly 100 stems to the acre with a height of 65 feet and an average diameter ranging round 11". No further thinning appears to have been made since the initiation of the experiment.

pronouced in the second period 1928-29 as the underwood developed. In this period the *Antidesma* plots put on roughly three times as much teak increment as the *Swietenia* plots. The other species* follow the same sequence between these extremes in both series in agreement with the height data. The marked difference between the effects on the overwood *of underplanting with different species is of great importance* and has not hitherto been demonstrated either in Europe or the tropics.

7. The underlying causes of this difference can only be extreme sensitivity of teak to root competition as crown competition did not come in. Coster's recent physiological investigations shew that teak roots have an exceptionally high oxygen requirement; it is accordigly a shallow rooter and requires a well aerated soil. The suitability of a species for association with teak will depend mainly on its root system and the more it roots in the same soil layers as the teak, and the more its specific requirements on mineral food and oxygen coincide with those of teak, and the greater its root activity, the greater will be its detrimental effect on the increment of the teak.

The underplanting problem becomes unexpectedly wide, for the effect of an underwood on the overwood thus depends on the physiological peculiarities of the species in question, and the extent to which it will compete with the teak in the soil probably varies with climate, *with density of overwood and underwood, and above all with the* soil itself.

8. A comparison of the underplanted plots in which the teak is doing best, with the surrounding controls similarly thinned and similarly raised with *Leucaena* interplanting leads to the following conclusion. No clear difference in height exists, but the diameter measurements show a steadily increasing difference in favour of the plots not underplanted. The favourable influence of the *Leucaena* is therefore not equalled by any of the species tried.

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* The other species used were *Actinophora fragrans*, *Pterocarpus indica*, *Gluta renghas*, *Cinnamomum iners*, *Eugenia subglauca* and *Protium javanicum*, the last being dropped out as uncomparable with the rest. The others are given in order of increasingly detrimental effect on the teak growth.

9. For determining the effect of the underplanting on the branchiness of the teak, the height of the lowest green branch was taken. The cleaning of the teak was found to vary greatly with the species used until the teak canopy closed again. There is again close agreement between the two series of plots.

10. The effect of the opening up of the teak was studied in the plots not underplanted. It has brought about a very big diameter and volume increment but only slightly improved height growth. The branchiness is virtually the same as for heavy thinning.

11. The volume production of the underwood has been considerable with several species, but has been largely at the expense of the overwood. As the species tried in these experiments have very little value in comparison with teak, the gross value of the underplanted plots is far below that of the pure teak plots.

12. *General conclusions.*—In Europe, the main object of underplanting is maintenance and improvement of the soil, and in older pure crops of light demanders it is essential to prevent the otherwise inevitable detrimental weed growth ; economic advantages are only a secondary object. In the East Indies, on the other hand, a justification of underplanting must rest on economic grounds as the function of soil protection is so exceptionally well carried out by initial interplanting with *Leucaena*, and as it is very usually possible to get in a natural undergrowth with protection from fire and grazing. Underplanting in the East Indies must accordingly aim at giving a higher total money yield than can be obtained without it. The results of experiments hitherto carried out shew that underplanting can only successfully be done on good soils and the species selected must fulfil very special conditions. It must not only be physiologically suitable for association with teak, but its value production must exceed the drop in that of the teak caused by the root competition which will occur. None of the species tried at Margasari fulfils this latter condition. On the other hand, experience to date suggests that an experiment on good soil with *Dalbergia latifolia* should be very well worth trying, with the overwood heavily opened up.

This matter of managing teak with very heavy thinning and underplanting valuable timber species is capable of many variations and has great possibilities; on good soils, it offers a promising field of research.

PLANTING UP GAPS IN DECIDUOUS FOREST.

BY A. F. MINCHIN, I. F. S.

The illustrations (Plate XVIII) were taken in Begur Range of Wynaad Division, Madras Presidency. They are meant to illustrate groups of teak which had been planted in June 1931 and are shown as developed groups about 19 or 20 months old.

In a coupe that came under selection fellings in deciduous forest of very high quality, about two trees to the acre were extracted in 1930, only big stems of teak, rosewood, *venteak, Pterocarpus marsupium* and *Terminalia tomentosa*. In the ensuing hot weather of 1931, gaps that had possibilities for artificial regeneration with teak were selected: in all 162 gaps dotted about irregularly over 300 acres. The *débris* of branchwood was heaped up to 3 feet high and burnt on spaces of up to about 25 feet square, centrally in the gaps. In June 1931 teak "stumps" were planted 4′ × 4′ on the burnt squares.

In some cases we have put *Pterocarpus marsupium* and rosewood on the edges of the 'groups.' We cannot say yet whether they will be a success or not. Deer and bison damage them much. The teak is also liable to destruction now and then by elephants. The latter like leafy teak saplings to slap their sides with. I expect it makes a nice noise. However cutting back the damaged ones costs nothing, and they sprout again indomitably.

Expenses per gap are :—Heaping and burning, 8 annas; staking, soil-working and planting, 7 annas; nursery charges on plants, say 3 annas. Soil-working means digging to about 6″ depth within circles 18″ wide.

The regeneration of gaps in the range I write about is confined so far to two coupes, of together about 600 acres. In these, a forest guard on Rs. 18/- and a watcher on Rs. 12/- do whole-time work, weeding and tending the 'gaps.'

No. 1. Teak stumps newly planted in October 1931.

Nos. 2 and 3. Successful groups in January 1933.

The grown-up " group " illustrated (No. 3) was the best shown to me. But that was in January 1933. In February 1933 an elephant demolished it. There are many gaps in which height growth is slow, and perhaps only one or two plants have shot up well ; but no single gap has been a complete failure. The Ranger who has been in charge is M. P. Subbayya.

In making these groups we try to avoid drip. It is not uncommon to find the best young teak growth on the side of the group that gets least of the *morning sun.* This phenomenon has been observed not only in groups but also in certain plantations. Mr. H. P. Ward first drew attention to it. Gap planting was first tried in Wynaad Division in 1911 and on to 1917. Mr. Wimbush tried the same thing about 1927 in Mount Stuart forests of South Coimbatore Division, and then re-introduced it in the Wynaad Division.

I have not tried to show a justification for the rate of expenditure incurred per gap. But in the forests concerned natural regeneration of teak does not take place, as far as one can see.

AMUSING INCIDENTS ON SHIKAR.

BY RANDOLPH C. MORRIS, F. Z. S.

I was out one day in the jungles with a young American lady, niece of a couple who followed us a few yards behind. Walking quietly along (we hoped to see bison) a rustle was heard and across our path ran a Mouse Deer : " What was that " queried the fair one and my reply " a Mouse Deer " was received with heightened colour and a look of indignation. Annoyance was registered in fact, that I should presume to make her believe that the creature was a mouse and for having called her " Dear ! " Soon after this we saw bison. Her sense of humour later prevailed when she learned that I had not tried to be funny.

(2)

In camp : Our kitchen cooly, a Sholaga, had been told to clean out a kerosene tin for our drinking water. His efforts to get rid of the

taint of kerosene were not very successful. Seeing this one of the Sholaga shikaris took the tin from him muttering " only a fool would try to clean a kerosene tin with sand," seized some cowdung and vigorously rubbed the interior of the tin with the same !

(3)

Word had been brought in late of a tiger kill. The kill was a long way off, and it was obviously useless attempting to reach the spot that day. On arriving at the scene of the kill the following day, I was told that the tiger had come to the kill the previous night, and that it was a pity I had not been there. However the man said " the tiger must be very hungry as I prevented him from feeding last night." In reply to my query as to what he had done he replied gleefully and with engaging frankness that he had stood on the machan, shouted and thrown stones at the tiger on seeing it approach in the moonlight ; needless to say the tiger did not turn up again !

(4)

I once came across an old reservoir built on the ridge of a hill ; remarking to one of the locals that it seemed an unusual place for a reservoir I received the information that there were three such on the same ridge, and that they had been constructed by a woman very many years before with money saved from selling chickens ! He ended his story with a sigh " Only a woman would make reservoirs in such foolish places." I laughed and said " Who told you this ridiculous yarn ?" and received the reply " Wise men like yourself ! "

(5)

A few years back while visiting a sportsman camped at " B " I learned that he was troubled by the over-officious attentions of the local Forest Guard who had criticised his having shot a tigress and a she-bear on the grounds that they were both females. I considered it best to send for the Forest Guard and, telling him what I had heard, remarked that my purpose in visiting " B " was to go after tiger and bear ; and that as it was possible to mistake their sex, I would require his services to guide me in the matter. The man, visibly agitated, thereupon assured me that on a further study of the rules he had found that the shooting of both males and females of tiger and bear was most desirable !

The same man expressed doubt to another sportsman as to whether a solitary elephant that was known to be in the neighbourhood was a proscribed rogue or not, on hearing that the sportsman wished to go after it. " As you are in doubt about it," said the sportsman, " and as you know the description of the animal I would like you to accompany me after the elephant, and you will be able to judge if it is the proscribed rogue or not." The Forest Guard's agitation was intense : " Sir," he replied, " that is not necessary, I am positive that the elephant is the rogue, in fact I am sure of it ; it is highly desirable that you should shoot the same, and you may do so without my assistance, especially as I have very important work to do immediately at " B " ! !

(6)

A friend was sitting one afternoon on a high bank overlooking a panther's kill in the stream bed. Half dozing he suddenly became very wide awake and apprehensive on hearing apparently close behind him, a low growl. As the growls got louder and more menacing he felt his hair slowly rise and his spine turn to water, until he could stand it no longer. Swinging round (letting off his rifle as he did so !) to face the brute, he saw a large mountain Mongoose quickly disappear from off a rock.

(7)

A couple, brother and sister (a delightful pair), were out shooting small game near camp, and the latter got separated from her brother while stalking peafowl. Receiving no replies to her whistles she became alarmed and started to call : again no response, and hurrying forward she came on her brother standing behind a clump of cactus a few yards away ! In answer to her reproaches he said : " Well, I am shooting for the pot, and if you want something to eat you mustn't make a noise ! "

(8)

He had a habit of dropping off to sleep when on a machan, and would then move about in an extraordinary way. On one occasion he awoke to find himself sitting with his back to the kill !

(9)

Recently a Game-photographer paid a visit to these parts and laid out about a dozen Flashlight cameras with trip wires: after a fair *amount of success I one day received the following note from him :*

" Yesterday, while inspecting my cameras over kills a tiger growled, I thank you : I am leaving this jungle," and he did !

(10)

I once offered to sit up over a tiger-kill with a sportsman, whom I knew had had little experience. My offer was rejected with the words : " Thanks, but I *always* (!) prefer to sit up alone, one gets better results you know ! " but he did not mind asking me to meet him on the spot the following morning in case he wounded the tiger. On my arrival I found him still on his machan and approaching the foot of his tree, I discovered the kill had been completely devoured; the tiger having had a hearty feed while our sportsman slept the sleep of the undisturbed.

CALOPEPLA LEAYANA LATR. IN THE *GMELINA ARBOREA* PLANTATIONS AT NAMTU, SHAN STATES,

BY D. J. ATKINSON, I. F. S.

History.

1928.—The first record of *Calopepla leayana* in these plantations is contained in my Inspection Report of July 1928 (referring only to the Railway Series as the River Series had not been started. The following is an extract therefrom :—" Defoliation, if severe, would be likely to be of some importance in retarding the increment. Fortunately, however, it is very slight, owing to an extremely high rate of parasitism by a chalcid pupal parasite. On the whole danger from insects appears to be slight, and need cause little anxiety at present."

A further extract from the same report is interesting :—" Weed growth, particularly ***thetke*** (the thatch grass ***Imperata arundinacea***),

is however very heavy and is likely to cause much more damage and loss of increment than insects."

1929.—The following extract from my diary a year later (June 1929) speaks for itself :—" From a zoological point of view conditions are uninteresting in the extreme. There is even less sign of insect attack than last year, possibly because my visit was somewhat earlier. *Calopepla* is of course present, but in comparatively small numbers, particularly in the new regeneration area near Namtu.

According to Mr. Allsop the adults at present to be found are of last year's final generation out of hibernation. This seems to be borne out by their appearance. No young beetles were seen. As the tending of these plantations is comparatively speaking intense, and there are always several subordinates working in them, I suggested to Mr. Allsop that all subordinates and coolies should be shown the insect in all its stages and instructed to destroy all those seen during the course of their day's work. Hand-picking, in fact. If that is done now, at the beginning of the season the insect will have little chance of multiplying to any serious extent."

1930.—The plantations were visited during the latter part of August, and I then noted that defoliation has been serious this year for the first time (Railway Series). Defoliation had occurred only in patches and where most serious was noted to have resulted in the dying back of the terminal twigs for a foot or so of their length. Up *to this date the insect, though of course occurring in the River Series,* had failed to do any damage there.

1931.—I was unfortunately on leave during this year and did not myself see the plantations. I visited them, however, in February 1932, shortly after my return, and saw the results of the defoliation of the preceding rains.

River Series.—These plantations were in excellent condition, only one small area of a few acres having been seriously defoliated, and that once only, after which the insect completely disappeared, probably through parasitism.

Railway Series.—This presented a very different picture, defoliation having been very severe and having been complete twice, once by the first generation at the end of June and again by the second generation in September. The following, extracted from my diary for February 1932, gives a picture of the then existing conditions:—"In areas where previously growth had been reasonably good, the trees are now covered with short, stunted, epicormic branches, the main branches all dead or dying, and areas such as the northern portion of 1927 or where *thetke* is prevalent and where growth has never been good, have ceased to bear any resemblance to a plantation, search revealing the planted species as miserable, stunted bushes in a sea of weed growth, many being dead to ground level."

The rains of 1931 were, as is well known, very short and unfavourably distributed, characterised by long sunny hot spells with no rains at all, conditions which are certainly favourable to the insect, if not definitely unfavourable to the host tree. It was also remarked that all natural *yemane* (*Gmelina arborea*) were severely defoliated during these rains.

1932.—The plantations were visited during both June and July.

River Series.—Old beetles of the previous year (ex-hibernation) were in fair numbers, engaged in feeding and egg-laying. Immediate hand-picking was recommended and some two lakhs of beetles were subsequently reported to have been destroyed. Parasitism of the resulting generation was later found to be high, and little serious defoliation occurred. No second generation has yet materialised and the insect has practically disappeared. These plantations have not therefore suffered any appreciable defoliation this year and their present condition is reported to be excellent.

Railway Series.—At the time of my first visit the first generation of the year had reached only the young larval stage, due mainly, it is thought, to the heavy rains at the end of May. There were large numbers of old beetles, however, and it was forecast that, given favourable climatic conditions, defoliation would soon be complete. This was realised by the time of my next visit in July when the insect was present in countless numbers, soon completely exhausting the

available foliage. These plantations were shown to have been practically moribund in February, as the result of the severe defoliation of 1931 (this statement is qualified below). The complete defoliation of this rains has, of course, further thrown them back, and the second flushing has been extremely retarded and poor. As a probable result, *i.e.*, through starvation, the population of insects has been very considerably reduced and the D. F. O. writes dated October 3rd, " I found just a few beetles, larvæ and eggs in all plantations, but they had made no appreciable attack on the few small new leaves which have been put out and so must be fairly scarce." Here also, therefore, a second generation has, to all intents and purposes, failed to materialise.

Effect on the Plantations.

The cumulative effect of the insect attack, of which a condensed history has been given above, is interesting. In the Railway Series it has been disastrous—in the River Series unimportant. This conflicting result calls for some explanation, which I suggest below.

Wherever *yemane* occurs it is accompanied by its parasite *Calopepla*, severe defoliation by which occurs periodically. Yet the Railway Series Plantations at Namtu are the only ones known to me which have succumbed as the result of defoliation. Other plantations have, of course, been wiped out by *Loranthus* or *sambhur*, for *yemane* appears to be a delicate species,—but not, I think, as a result of defoliation. *Calopepla* is a comparatively slow breeder, only two full generations being passed through in the year, and it would, in my opinion, only be in the very unlikely event of several seasons exceptionally favourable to the insect following one another consecutively that a plantation of normal vitality would succumb.

The crux of the matter is, I think, this question of " normal vitality." The criticism made in the second extract from my diary of 1928 given above is—I think anyone acquainted with these plantations will agree—a true one. With the exception of a few patches, the plantations of this Railway Series have never shown anything but extremely poor growth, the area is swamped with *thetke*, and the soil

has, I believe, been definitely shown by Mr. Allsop's analyses to be unsuitable to *yemane;* it is my opinion that the plantations would never have come to anything, quite apart from defoliation. The first defoliation in 1930, patchy though it was, had an abnormally severe effect on the plants; the defoliation of 1931 undoubtedly killed off a large proportion of the extremely indifferent stock, and as a result in 1932, the remaining stock had to support an excessive population of the insect. I consider it very unlikely that a similar state of affairs will eventuate in the River Series, where growth is excellent and the vitality and resistance of the plants consequently very much greater. I should, therefore, very strongly deprecate the cessation of planting in the River Series, solely on account of fear of the insect

Future Prospects.

Apart from the unlikelihood, in my opinion, of the plantations of the River Series succumbing to *Calopepla* attack even if left to themselves, it is much too early to abandon hope of at least a partial control of the insect. Hand-picking of the old beetles at the beginning of the season, though as a method of control usually productive of considerable mirth, must be of great benefit, and I should hesitate to say that the collection this year of some two lakhs of adults in the River Series, just as they were engaged in oviposition, had not some effect on the subsequent disappearance of the pest with so little damage. Destruction of the insects' hibernating quarters, in the shape of dead trees in the surrounding forest, is also possible and would go far to reducing the overwintering population, on which the virulence or otherwise of the following year's defoliation is dependent.

Thirdly, we come to the possible use to be made of parasites. *Brachymeria* sp. the chalcidoid pupal parasite with which all our experiments so far have been concerned, is undoubtedly effective. Without any assistance it was found to have accounted for 36 per cent. of the first generation in the River Series this year, and though one could certainly not hope to achieve complete control with a native parasite which is already in equilibrium with the host, one can hope, by upsetting to a certain extent this equilibrium, to weight the scales

in favour of the parasite. So far we have had to be content with experiments on the technique of rearing this parasite and on the control of its development, and have not yet been in a position actually to use it against the pest. This has mainly been due to unfortunate circumstances, such as the writer's absence on leave last year, and the consequent loss of our laboratory stock, and the lack of trained staff. The whole of this year's experiments have been carried out by an entirely untrained subordinate of the division, to whom great credit is certainly due, but who was, quite naturally, incapable of dealing with emergencies. Nevertheless, we succeeded in rearing the parasite in numbers, —thousands are, of course, aimed at,—and in carrying out a series of experiments which have shown the possibility of retarding the development of the parasite within the host for a period sufficient to permit of its being held in safety until required. It is, therefore, to be hoped that unless some catastrophe occurs, we should be in a position to start rearing the parasite in numbers at the commencement of the next season.

In addition to the pupal parasite discussed above, it appears likely that a free-living insect such as *Calopepla* will be found to support other parasites somewhere within its range, the introduction of which into Burma should be of great benefit. This aspect of the problem has already been taken up with the authorities in India and the Federated Malay States, though it would hardly be reasonable to hope for any satisfactory result under a year or so.

The main difficulty with which we are faced is, as indicated above, lack of trained staff, and in the writer's opinion, the procedure now definitely desirable is the provision of a small special allotment for the conduct of this investigation. He would estimate the amount required at Rs. 3,500/- per annum, for say two years, made up as follows :—

	Rs.
1 Assistant in charge of investigation, pay ; Rs. 200 × 12	.. 2,400
2 Field men, pay Rs. 30/- : Rs. 60 × 12	.. 720
Purchase of material, cages, etc. ..	.. 380
	3,500

The further conduct of such an enquiry as this, which requires a whole-time staff resident on the spot, is quite impossible with the permanent staff at present at the writer's disposal, which has been cut down to a maintenance minimum.

Given a satisfactory outcome of this investigation, and in particular, of that part of it relating to an introduced parasite, it seems reasonable to hope that a sufficient control would be achieved, in combination with the effects of the mechanical methods outlined above, to allow of the host plant being raised *successfully* over the large areas desired.

NURSERY MANURING EXPERIMENTS AT NEW FOREST.

BY P. N. DEOGUN, P. F. S.

The term ' manure ', derived from the French *manœuvre*—to work by hand, originally meant any process by which the soil could be improved for the production of crops. Gradually the use of the term became limited in its meaning to the materials used for improving the fertility of the soil. The elements of plant food most likely to be needed in soils are nitrogen, phosphorus and potash in varying combinations. Both humus and lime are also required so that our list of the various manures necessarily has to contain the above elements in different combinations in order to be useful in the improvement of soils.

Manures may be grouped into two main classes (*a*) natural, *e.g.*, farmyard, sewage, etc., and (*b*) artificial, commonly called fertilizers, such as phosphate of lime, bone dust, sulphate of ammonia, etc., which are commercial manures. Manures again may be divided according to the materials from which they are made, *e.g.*, bone manures, wood manures, and fish manures, or according to the constituents which they mainly supply, *e.g.*, phosphatic manures, potash manures, nitrogenous manures, etc.

Farmyard manure, seaweed, green manures, malt dust, spent hops, manure cakes, wood dust, shoddy, hoofs, horns, dried blood, sewage, etc., form some of the natural nitrogenous manures, while nitrate of soda, sulphate of ammonia, calcium cynamide, and calcium

nitrate, are some of the manufactured nitrogenous manures. These all go to supply nitrogen in a form best available for plant use. Superphosphates, *basic slag, etc., form the phosphatic group of manures and* are used purely for their phosphatic benefit. Wood ashes, some products of sugar refinery, and potash from the Prussian mines belong to the potash group. In some manures, such as bones, fish and meat, and Peruvian guanos, both nitrogen and phosphates are available. There are some which may be called miscellaneous manures such as salt, lime, etc., which mainly cause a mechanical and physical improvement of the soil.

Among all the above, farmyard manure (excreta and litter) alone has all the constituents required by crops and so is sometimes called the ' perfect manure '. The following shows an analysis of a representative sample of farmyard manure :—

Water ..	75·42	Soda	0·08
*Organic matter ..	16·52	†Phosporic acid ..	0·44
Oxide of iron and alumina	0·36	Sulphuric acid ..	0·12
Lime ..	2·28	Chlorine ..	0·02
Magnesia ..	0·14	Carbonic acid ..	1·38
Potash ..	0·48	Silica	2·76
			100·00

Broadly speaking, farmyard manure will contain from 65 to 80 per cent. of water, from ·45 to ·65 per cent. of nitrogen, from ·4 to ·8 per cent. of potash, and from ·2 to ·5 per cent. of phosphoric acid.

Everyone who has anything to do with the raising of crops knows that they cannot be grown year after year over the same area without the use of some manure. The need of a manure may arise by the repeated raising of crops which take away certain elements from the soil thereby impoverishing it, or from the initial lack of certain elements, *bad physical condition, etc.*

The use of manures is an old story. To begin with, when the population was small, the area available for crops was large and the

* Containing ·59 per cent. nitrogen which is equivalent to ·72 per cent. ammonia.
† Equal to phosphate of lime ·96.

people had no settled life ; it was the common practice to cut down the jungle growth, burn it, mix up the ashes with the soil, cultivate the land for one or two crops and then shift on to another locality to repeat the same process over again. This can still be seen among the *taungya* (*jhum* or *kumri*) cultivators. But with the rise of civilization and the need for a more settled life, it was necessary to keep up the capacity of the same soil, and this was done by the use of farmyard manures, the rotation of crops and the use of leguminous species.

A further rise in population and the use of mechanical labour and consequent lessening in the number of farm cattle, necessitated some further work which resulted in the discovery of chemical manures (thanks to the work of Liebig and later on by Lawes and Gilbert), and to-day we find an enormous demand for chemical manures or fertilizers in countries and places where the use of mechanical labour is in vogue, or in rubber and other plantations where there is very little farmyard manure available.

The use of manures largely depends upon the requirements of the plants concerned and the locality where they are grown. What may be beneficial for one species at a certain place may not be so for another species or at another place. For the economic use of manure it is essential to carry out a few test experiments in the vicinity of the area to be manured. One can, however, safely begin by using the farmyard and artificial farmyard manures which not only supply all the elements required by plants but also improve the physical conditions of the soil by the introduction of humus which is so essential. Light soils become more consolidated and are better able to retain the manurial ingredients and moisture, and become less liable to ' burning '. Heavy soils are opened up for better aeration, drainage and working.

Manuring experiments were begun in the New Forest nurseries in 1927 and continued to date. The procedure as to the kinds of manures and the doses applied varied from year to year. For the first four years only chemical and farmyard manures were tested, but in the fifth and sixth years (1931 and 1932) artificial farmyard and green manures were introduced. The results have not been entirely consistent, but on the whole the benefit of the use of certain manures is clear.

Except in a very few cases, the manured beds showed superior results to the unmanured ones.

As far as possible, comparable beds were chosen in a set each year and the same treatment as to the soil working, planting, watering, weeding, shading, etc., was employed in all beds in a set. The experiments were carried out with 3 species, *viz.*, teak, *Gmelina* and rosewood, the last being selected as a leguminous species. Results were assessed on the average height of the plants of a bed at the end of the first growing season.

The following is a brief summary from year to year :—

In 1927, farmyard manure (5 tons per acre) and chemical manure ($\frac{1}{2}$ cwt. ammonium sulphate $+\frac{1}{2}$ cwt. potassium sulphate$+$ 13 cwt. superphosphate per acre) were compared for all three species with replications. Results were not consistent, most probably owing to initial differences in the fertility of the beds, which had been newly made from recently abandoned cultivation. On the whole, it could be said that the farmyard manure gave the best results.

In 1928, different amounts of sodium nitrate (15·5 lbs. and 77·8 lbs. per acre), and ammonium sulphate (15·5 lbs. and 147·8 lbs. per acre) were tried for two species (teak and rosewood) with 3 replications. Significantly superior results were given by the lighter application of ammonium sulphate over the heavier application of the same chemical, and also over sodium nitrate and the lighter application of farmyard manure. The heavier dose of farmyard manure gave practically as good results as the lighter dose of ammonium sulphate.

In 1929, only farmyard manure in three different doses (one set with 53, 107, 160 tons, the second set with 40, 80 and 120 tons per acre) was tried with teak. The greater the quantity of manure, the better the results that were obtained. 160 tons gave significantly superior results to 107 and 53 tons and 107 tons to 53 tons in one set and 120 and 80 tons to 40 tons in the other set, but the difference between 120 and 80 tons was not significant.

In 1930 again three different amounts (42, 85 and 127 tons per acre) of farmyard manure with 155 lbs. per acre of sodium nitrate and

RESULTS OF NURSERY MANURING EXPERIMENTS.

Year.	Species.	Average stem height in inches with its Standard Error and the total number of survivals, (in brackets) at the end of one season.										
		Control.	Chemical manures per acre.				Farmyard manure per acre.			Artificial farmyard manure per acre.		Green manure.
			½ cwt. $(NH_4)_2SO_4$+½cwt. K^2SO_4 +3 cwt. of superphosphates.				5 tons.					
1927	Tectona grandis.	*8·0±0·54* (51)	7·5±0·34 (74)				*8·0±0·52* (54)	..	..	..	..	..
"	"	**5·6±0·22** (139)	4·7±0·17 (154)				5·0±0·18 (166)	..	..	..	..	..
"	"	4·5±0·21 (114)	*5·6±0·29* (106)				*5·8±0·20* (202)	..	..	..	..	..
"	Dalbergia latifolia.	13·0±1·17 (543)	*13·7±0·22* (498)				*13·7±0·23* (492)	..	..	..	..	..
"	"	13·2±0·21 (520)	*15·6±0·24* (492)				*15·3±0·19* (504)	..	..	..	..	..
"	Gmelina arborea.	5·6±0·12 (715)	*6·8±0·11* (726)				*7·3±0·14* (688)	..	..	..	..	..
"	"	6·1±0·13 (692)	5·9±0·12 (709)				**6·9±0·14** (714)	..	..	..	..	..
"	"	7·4±0·12 (764)	*8·0±0·13* (711)				6·3±0·13 (712)	..	..	..	..	..
			$NaNo_3$ 15·5 lbs.	$NaNo_3$ 77·8 lbs.	$(NH_4)_2SO^4$ 15·5 lbs.	$(NH_4)_2SO_4$ 147·8 lbs.	5 tons.	5 tons.				
1928	Tectona grandis.	12·9±0·27 (252)	16·0±0·87 (120)	14·9±0·50 (132)	*17·6±0·59* (128)	**18·1±0·77** (122)	14·8±0·57 (130)	*17·6±0·51* (118)				
"	"	13·0±0·36 (250)	11·9±0·54 (115)	11·6±0·46 (130)	**14·1±0·52** (124)	11·2±0·55 (129)	11·8±0·47 (129)	*14·0±0·65* (122)	..	..	..	..
"	Dalbergia latifolia.	*15·7±0·35* (440)	14·5±0·46 (197)	14·1±0·51 (184)	**16·1±0·56** (204)	12·3±0·42 190)	15·3±0·52 (215)	14·4±0·54 (178)	..	..	..	..

RESULTS OF NURSERY MANURING EXPERIMENTS.

Year.	Species.	Average stem height in inches with its Standard Error, and the total number of survivals (in brackets) at the end of one season.										
		Control.	Chemical manures per acre.				Farmyard manure per acre.			Artificial farmyard manure per acre.		Green manure.
							53 tons.	107 tons.	160 tons.			
1929	Tectona grandis.	11·4±0·31 (232)	..	..	..	..	23·5±0·54 (244)	*26·6±0·80* (223)	**31·0±0·84** (257)			
							40 tons.	80 tons.	120 tons.			
"	"	12·0±0·27 (258)	..	..	..	..	24·7±0·50 (253)	*28·4±0·75* (250)	**29·7±0·75** (245)			
1930			$NaNO^3$ 155 lbs.		$(NH^4)_2SO^4$ 155 lbs.		42 tons.	85 tons.	127 tons.			
	Tectona grandis.	8·4±0·33 (149)	14·0±0·62 (132)	..	13·4±0·52 (142)	..	13·6±0·51 (157)	*14·2±0·57* (152)	**20·1±0·91** (153)	..	..	
"	Dalbergia latifolia.	6·2±0·10 (497)	6·3±0·12 (499)	..	6·1±0·12 (548)	..	7·6±0·15 (476)	*7·8±0·17* (432)	**7·9±0·20** (322)	..	..	
1931			124½ lbs.		124½ lbs.		42½ tons.	85 tons.		32 tons.	64 tons.	Lucerne.
	Tectona grandis.	5·7±0·11 (92)	6·1±0·12 (98)		7·2±0·16 (85)	..	7·6±0·18 (83)		*8·4±0·23* (80)	7·3±0·16 (92)	**9·8±0·30** (82)	5·9±0·12 (92)
1932							21¼ tons.	..	42½ tons.	32 tons.	64 tons.	Crotolaris.
	Tectona grandis.	5·5±0·09 (253)	..	..	..	..	*7·1±0·18* (250)	..	*7·5±0·15* (253)	6·6±0·11 (262)	**7·5±0·12** (260)	5·7±0·13 (259)

NOTE.—Significantly superior heights are in bold face type, next superior in italics.

ammonium sulphate were tried with teak and rosewood. Farmyard manure, 127 tons per acre, showed significantly superior results to the chemical manures. With teak 127 tons showed significant superiority over 85 and 42 tons but with rosewood there were no appreciable differences. On the whole the greater the quantity of farmyard manure the better the results that were obtained.

In 1931 the following were tried with teak :—farmyard manure ($42\frac{1}{2}$ and 85 tons per acre), artificial farmyard manure (32 and 64 tons per acre), green manure (lucerne raised in the bed and dug into it), sodium nitrate ($124\frac{1}{2}$ lbs. per acre) and ammonium sulphate ($124\frac{1}{2}$ lbs. per acre), the total quantity of the two chemical manures being made up in 4 applications. The bigger dose of the artificial farmyard manure gave significantly superior results to the bigger dose of farmyard manure which in turn gave significantly superior results to all the rest. The 1931 experiment was repeated in 1932 with *Crotolaria sericea* for green manure dug in the bed before flowering and a fortnight before teak planting, and with half the doses of farmyard manure. No chemical manure was tried. Heavier doses of farmyard and artificial farmyard manures gave the best and the same results followed by lighter dose of farmyard manure which was significantly superior to the lighter dose of artificial farmyard manure. Control and green manured beds were significantly the poorest of the lot. The artificial farmyard manure had got mixed up with earth from rat burrowings and so the results were not as good as in 1931.

General.—The above experiments demonstrate that heavy applications of chemical manures are not required in these ordinary soils but a liberal application of farmyard and artificial farmyard manures result in marked improvements in the stock raised if the soil has become at all exhausted. These latter manures work in two ways, *viz.*, by first improving the physical condition of the soil and then by providing the necessary supply of nitrogen and other ingredients required as plant food.

The artificial farmyard manure has given very satisfactory results and is preferable to the more expensive real farmyard, chemical and green manures. It is really a synthetic manure having nearly the

same components as real farmyard manure with the difference that its ingredients have been built up by the agency of added bacterial stimulants.

This method of turning straw and other farm waste into a useful manure was discovered by the Rothamstead workers and has a double benefit to the farmer. Whereas it disposes of the refuse, it also provides a manure of great value at a cheap rate without the necessity of keeping herds of cattle or resorting to the expensive chemical fertilizers. The idea has its source in the common practice followed by farmers from time immemorial. Every one is familiar with the way a farmer spreads out the waste grass underneath his cattle, and keeps the same from day to day in a big heap to be utilized when ripe. The hillman collects pine needles for this purpose of making a bedding for his cattle and utilizes the same as manure later on. The Rothamstead workers worked out the whole theory on a scientific basis and the later workers tried to evolve different methods of making this manure and to shorten the time of its decomposition. All of them however follow the same principle.

The easiest method of making artificial farmyard manure in India can be summarised as follows :—Dump all organic refuse from weedings, cleanings, etc., from time to time in a pit. When a sufficient quantity has accumulated and when the work is slack, take out some of this and make a heap about $6' \times 6' \times 2'$. Moisten the whole mass thoroughly with either a thin concoction of cowdung and water, or by a solution of sulphate of ammonia and chalk ($\frac{3}{4}$ cwt. and 1 cwt. respectively per one ton of organic refuse). The idea is to provide soluble nitrogen in a neutral or slightly alkaline form which is favourable to the fermentation processes involved.

Care should be taken that the heap is moist and is forked occasionally to admit of air which is essential for the quick growth of the bacteria. After about 5-8 months depending upon the temperature of the locality the heap will break down in a friable mass with an earthy smell and brown colour. This resultant mass which is commonly

known as the *activator* or *starter* is further used for the manufacture of the manure at a quicker rate.

Another heap of similar size is made from the waste pit, and one-third of the supply of activator manufactured as above is added, and then the whole mass moistened with a concoction of cowdung and water or only water and forked occasionally. The addition of cowdung or sulphate of ammonia quickens the process of fermentation but is not essential. The heap must be kept moist and forked; three forkings are required the first after a fortnight, the second after a month and the third after 2 months, and water or a concoction of cowdung and water can be added at the time of forking if the heap is found to be getting dry.

This mass breaks up after about 12 weeks and is fit to be utilized as manure, but in order to have a sustained supply, only one-third of the manufactured manure is removed and utilized directly in the fields or stocked in pits and the remaining two-thirds is supplemented with raw material so that a similar heap is made and the process of moistening and forking continued till the manure is made.

Thicker organic stuff should be chopped up into smaller pieces in order to quicken the process. Animal urine can be used instead of cowdung or sulphate of ammonia. If nitrolin is used instead of sulphate of ammonia, the necessity of chalk is avoided.

The artificial farmyard manure used in 1931 and 1932 experiments was prepared as follows:—In May 1930 a pit $15' \times 15' \times 3\frac{1}{2}'(2' + 1\frac{1}{2}'$ made up from the pit earth) was dug in the open. From 4th June to 20th August all the organic stuff from weedings and cleanings in the nursery beds was dumped in the pit from time to time. By the 28th August when the pit was about $\frac{3}{4}$ full 4 canisters full of cowdung (40 per cent.) and water (60 per cent.) concoction were sprinkled on top more or less uniformly.

From 6th September 1930 to 6th June 1931, more organic waste was dumped in. The pit was by then nearly full. On the 19th July 1931 about $4\frac{3}{4}$ cwt. of manure was taken from the bottom layers and

used for the 1931 experiment. On an analysis by the Biochemist this lot gave a nitrogen per cent. of 1·132 as compared to ·512 per cent. given by the ordinary farmyard manure purchased locally. The balance was turned back in the pit and on 28th August 1931, 3 canisters of cowdung concoction were put in as before. $2\frac{1}{4}$ tons of manure out of the pit were used in the nursery beds from December 1931 to May 1932. In June 1932 about $4\frac{3}{4}$ cwt. of the said manure was used for the experiment. On the whole about 3 tons of manure was got from what would have been just waste stuff.

FORESTERS SHOULD SELL LEAF MOULD MANURES.

By E. T. Ellis.

A sideline which a good many foresters have overlooked is the sale of leaf mould from the forests in the form of ready mixed manures. This is very much more profitable than most foresters believe, and provided that suitable materials are chosen sales may be effected at every season of the year, though those in the autumn and winter will generally speaking be much larger than those in the spring and summer.

Foresters should remember that there is an all the year round demand for well made leaf mould itself. This should be offered to nurserymen and to amateur and other small gardeners. To get the best results it should be a year old, however, and foresters as a rule would prefer a quicker return from their capital, as this they can always obtain by mixing the partially formed leaf mould just as it comes from the forest with any of the materials mentioned below.

Leaf Mould with Cow Manure.

Half-rotted leaves, *i.e.*, leaf mould which is in the course of formation can be rapidly turned to advantage if mixed with cow manure. I recommend foresters to use the following formula, but there are, of course, several alternatives:—

Leaf Mould	50 parts.
Cow Manure	50 ,,

If a layer of the half-rotted leaves is thrown into a pit, and then a layer of cow manure put on, and so on until the pit is full, this is a very good plan, and in most instances foresters will find that they can dig out the pit at the end of as short a time as six months, mixing the material very thoroughly together. This combination can be recommended with every confidence for use in general garden work at the rate of about a barrowful per each 4 square yards. This may sound a lot, but actually it is by no means too much.

Leaf Mould with Lawn Mowings.

Foresters who can get grass clippings in quantities from tennis courts, golf courses and so forth, should put on the market mixtures of leaf mould with these. Two grades are recommended in this instance, one consisting of quarter-rotted leaves with mowings, and the other with half-rotted leaves. The proportions are the same in both cases and are set out below :—

Leaf Mould	80 parts.
Lawn Mowings	20 ,,

Admixture should be very thorough in both cases, and in using quarter-rotted leaves it is advisable to moisten the pile with stable drainings or other organic liquid manure if possible, as this apart from greatly enriching the humus, also encourages rapid fermentation. The combination of the two substances should be thrown into a heap in the open air, and turned over once or twice. That prepared from half-rotted leaves is ready for sale at the end of a fortnight, while one or two months should be allowed to elapse before the other is sold. The rate I recommend for a ten pole or perch plot of horticultural ground is 100 barrowfuls. If the soil is already in a rich state, however, and a considerable amount of liquid manure has been used in the preparation of that form containing quarter-rotted leaves, rather less will prove sufficient.

Leaf Mould with Stall Manure.

Every forester should sell a mixture of leaf mould and stall manure, as he will find that this is one of the most useful of all com-

pound mixtures. It should mainly be offered in districts where stall manure is expensive and difficult to get, and it should be pointed out when supplying it that the amount of humus present is quite as much in most instances as if stall manure alone had been used, although the quantity of fertilising matter is not quite so great.

As to a formula, I recommend foresters to use the following :—

Leaf Mould	..	..	.. 75 parts.
Stall Manure	..	..	.. 25 ,,

The leaf mould selected for this purpose should be the half-made variety, *i.e.*, it should consist largely or wholly of half-rotted leaves. The stall manure, however, should be as fresh as possible, and contain a lot of straw. Admixture of the two materials should be very complete, and the combination should be built up in the form of large conical piles, these being turned over and watered every second or third day, so as to encourage fermentation and oxidation to take place. In many instances this combination of leaf mould and stall manure is fit to sell at the end of a week and foresters should recommend 80 cart-loads being employed to each acre, this in practice rarely proving too much, as the organic matter very soon disappears in soils which are of a very porous character. This combination can be fortified by the addition of small quantities of sulphate of ammonia, sulphate of potash, and double superphosphate, but most foresters will find it is too much trouble to use these, and should recommend customers to employ them separately as surface dressings.

[Mr. E. T. Ellis, the writer of the above article, in addition to being editor of " Black's Gardening Dictionary," is editor of Bardswell's " Herb Garden," and Cook's " Gardens of England," 2nd Editions. He is also author of several horticultural works, *e.g.*, " Allotment Gardening for Profit," " Insect Pests," " Jottings of A Gentleman Gardener," and " Jottings of An Allotment Gardener." He wishes us to state that he will be very pleased to hear from readers and to help them to solve their problems as these occur. Letters should be sent to him at Weetwood, Ecclesall, Sheffield, England—Ed.].

DEODAR SOWINGS IN THE DRY ZONE.

BY KAILASH CHANDRA, FOREST RANGER.

The dry zone belt commences from Wangtu, 118 miles from Simla upwards along the Sutlej river banks, and in Bashahr State in the Simla District in the inner north-west Himalayas. This tract is mostly covered with deodar forests which are pure, other conifers of minor importance being *kail* (*Pinus excelsa*), *neoza* (*Pinus gerardiana*), spruce and fir. Much has already been written and said on the silviculture of deodar in the wet zone, but this is not all applicable to the dry zone deodar, which needs quite a different treatment, as the monsoon rains are almost absent in this tract, so that it is more difficult to get deodar regeneration. The monsoon rain amounts to only 2″-4″ from July to September, and the monsoon transplanting of deodar seedlings is therefore impossible except with the aid of an artificial water-supply which is very expensive. There are occasional good falls in autumn but the autumnal transplants cannot possibly survive as they have got very little time for development, because with the approach of the cold weather, the water in the soil freezes at the higher elevations and the thaw tends to pull up the roots of un-established transplants.

The only course left is for the forester to try artificial regeneration by direct sowings. This too is not an easy job owing to the dry condition of the soil, but there is every chance of success if direct sowings are carefully and cautiously done. Observations by the writer in connection with direct sowings are given below and may be of interest to those who are dealing with such forests :—

(1) The area to be tackled under direct sowings must be thoroughly burnt. The cut bushes and slash should not be burnt in heaps but must be burnt spread over the whole soil.

(2) The soil must be dug 9″-12″ deep, removing boulders out of the seed beds. This will enable the roots of the seedlings to go deeper down, with the aid of the moisture of the melting snow in spring and in the beginning of the hot weather. Seedlings thus sown will stand

any amount of drought. Sowings were done on these lines in Compartment 175b. (old 37f) over 10 acres, in Compartment 172b (old 37c) over 2 acres, and in 169b (old 36c) over 14 acres in November 1931. The success was 95 per cent. in Compartments 175b and 172b and 50 per cent. in 169b. The area in Compartment 169b was left blank for the last 10 years, as all sowings has failed here. The seedlings in the first two compartments were 10″-14″ high after 10 months, growing like weeds with a dark green colour. The total rainfall in this region was 3″ including snow from November 1931 to August 1932. The summer of 1932 was so hot and dry that in many forests seedlings of 3 to 4 years died, and even the grass and other bushes suffered badly. It was most gratifying to note that the seedlings in the above mentioned forests did not suffer appreciably although no artificial watering was done.

(3) Sowings should be done in shade as snow moisture is available longer than in the open. The shade and shelter must be opened out when the seedlings are 4-5 years of age and 2′-3′ high, as shade after this age does them more harm than good, because the scanty rainfall in this dry zone is intercepted by the upper canopy and the young seedlings underneath are deprived of the rain and dew water. At this stage also they need more light for crown development and if the upper canopy is not removed the seedlings get stunted and form a bushy growth.

(4) The seedlings sown in the open can be protected against the hot sun by erecting screens of *kail* and *Indigofera* branches and fern leaves. These 3 species have been proved very useful for artificial shade, because they protect the seedlings against hot sun up to August and thereafter begin to decay when no longer needed for shade. Then they rot in the seed beds and serve the purpose of manure for the seedlings. To erect heaps of chips from the felling refuse is harmful, because they are knocked down by wind or wild animals, and they certainly smash the young seedlings underneath if not removed in time. These chips have got to be removed in September and this costs extra time and labour,

(5) No success is possible in the dry zone until and unless the area is protected against grazing, because grass and bushes are scanty, and sheep and goats are particularly destructive in browsing and smashing the plants.

(6) No deodar sowings should be done below 8,000 feet in the dry zone, as snow moisture does not last long enough below this for the young seedlings to survive.

(7) Weed growth is scanty in the dry zone and only a light bush cutting is needed once a year at the end of September or October, just to free the tops of the seedlings ; the other bushes must never be cut away.

An experiment on soil burning proved to be most useful in the case of field crops. In the compound of Purbani Rest House two beds were prepared adjoining each other. In one bed dry leaves, etc., were collected and burnt over the whole bed, the other bed being left alone. Both the beds were sown with turnip seed. The germination was the same in both the beds, but after 30 days the burnt bed contained plants 15″ high, having a dark green colour, while the unburnt bed had plants only 3″-4″ high and they looked pale and most unhealthy.

EXTRACTS.

PUNJAB FOREST CONFERENCE, 1933.

This Conference was opened in February by Sir Sikandar Hayat Khan, Revenue Member of the Punjab Government. In the course of his opening speech Mr. C. G. Trevor, Chief Conservator, spoke as follows :—

I last had the pleasure of addressing you 2 years ago, and this morning I propose to review shortly the progress which has been made in the subjects dealt with in my last address and discussed at our previous conference. I mentioned to you the importance of the study of forest types and Mr. Glover contributed a very thoughtful paper on the subject which has been the foundation on which we have carried out research during the last 2 years. The result is contained in 2 papers dealing with the ecology of *Pinus longifolia* by Mohan and of spruce and silver fir by Parma Nand. As regards the natural regeneration of spruce and silver fir, I would point out that there has been in the past a great deal of talk on this subject but very little actual work. I prefer to see forestry carried out in the woods rather than in the office, and I must ask all Divisional Forest Officers associated with fir to take an active personal interest in the subject. It is incorrect to state that little is known about the natural regeneration of these species. Considerable areas have been regenerated both with spruce and with silver fir in the Kulu and Seraj Divisions under the Kulu working plan and very much more could have been accomplished in Kulu if the Divisional staff had interested themselves in the matter.

Research into the problems of the irrigated plantations has been persisted in and a considerable advance has been made. Sardar Bahadur Singh's Manual on the Irrigated Plantations supplies an up-to-date text book of all operations. Planting distances have been studied and increased with the result that very effective savings in original costs have been effected. Continual efforts have also been made to improve the irrigation of Khanewal plantation with the result that the number of waterings has been increased to 10. The reasons for failures of certain areas in this plantation have also been studied and it appears that the clue to a problem which has baffled us for many years lies in the hydrogen on concentration in the soil. It is hoped that more about this will be known the next time we meet in conference.

The cultivation of mulberry and *farash* (*Tamarix articulata*) has been studied, and perhaps the greatest silvicultural advance since I spoke to you lies in the elucidation of the problem of the propagation of the latter tree. Shortly after taking over charge of the Punjab, I was asked how to grow *farash* and I had to admit that I did not know. This reproach no longer exists, and thanks to work carried out by the Divisional Forest Officers, Multan and Montgomery, and the Silvicultural Research we have now a very fair idea of how to propagate *farash*, both from seed and from cuttings. A paper dealing with this subject will be discussed at the conference. As regards future research work, I would direct your attention to the subject of the inheritance of form characteristics in *shisham* into which I have directed an investigation. The possibilities of making use of water logged soil for plantations is also of considerable provincial importance, as is the possibility of finding a valuable exotic conifer for cultivation above the deodar zone and in the oak forests of the Outer Himalayas.

As regards silviculture and forest management, I would draw your attention to the series of forest leaflets which have been issued. These summarise not merely my own views but those of the forest adminstrations as a whole. They have involved a very great deal of labour and standardise the methods of carrying out all the operations of forestry in the Punjab. It is sincerely hoped that every member of the staff will make himself fully acquainted with this literature, part of which is being translated in Urdu. I am glad to say that although there is still scope for improvement, the general standard of forestry in the Punjab is a high one. Unfortunately our financial position is by no means so satisfactory. I fully realise, and I have done my utmost to make Government realise, that the greater part of our area is only protection forest which cannot be expected to do more than pay its way; but to be perfectly honest there is no gainsaying the fact that at one time the financial prospects of this province have been greatly exaggerated, and that the staff has been unduly inflated. Divisional Forest Officers must understand that they are responsible for effecting every possible economy in their divisions. It is not a matter of what staff they would like to have but a matter of what staff their divisions can afford to keep, and I regret to say that in this matter of economy, I have not always received the support expected from Divisional Officers.

I have now the very pleasant duty to perform of asking Sardar Sir Sikandar Hayat Khan to declare open the proceedings of this conference. Sir Sikander very kindly attended 2 years ago and addressed you in a speech which was printed in our proceedings. I have now had the honour of serving under Sir Sikandar for the last 2

years, and I should like to take this opportunity of publicly thanking him for all the assistance he has been both to me personally and to forestry in the Punjab during the time he has occupied his present exalted post.

Sir Sikandar Hayat Khan also made an encouraging speech in the course of which he said: The extent to which the retrenchment-cum-economy compaign has succeeded in restoring the financial equilibrium of the province, during a period of unprecedented stringency and stress, can best be judged from a comparison of the Provincial Budgets of the last two years with those of the pre-slump period. Those among you who have studied the current year's Budget will have noticed that as compared with 1929-30 the total expenditure under all heads is less by nearly two crores. This is no mean achievement, and reflects credit on our Finance Department as also on the various administrative departments. It is due to the unceasing vigilance and valuable initiative of the former backed by the ungrudging support and co-operation of the latter that the Punjab finds itself to-day even after facing three successive years of acute economic depression, in a much more satisfactory financial position as compared with other provinces with, perhaps, the possible exception of Madras. In this connection, your Chief—Mr. Trevor—has given us very valuable assistance and I should like to take this opportunity of conveying to him the appreciation of Government and also my personal thanks for his unstinted support and co-operation.

There have been during the past few months signs, feeble but perceptible, which if they continue and gather strength may prove to be genuine indications of the beginning of an era of a general revival. But until that eagerly-looked-for change clearly manifests itself, do not let us be lulled into false security or be carried away by false hopes. We are not out of the wood yet; and until we are well out into the open again, we cannot afford to relax, even partially, our efforts to effect every possible economy wherever there may be scope for it. It is therefore with some regret and not a little surprise that I have listened to Mr. Trevor's remarks which indicate that some of you have unfortunately failed to appreciate the gravity of the situation. You must remember that the Forest Department is pledged to make a substantial contribution to the provincial revenues; and it is still over-manned. It is true that the main function of your department is to conserve the existing forests and to plant and preserve fresh forests for the future generations; but it is equally important to remember that you are expected to discharge these functions efficiently and economically. You cannot expect the Legislature or the critical public outside to be impressed by these considerations even during normal times and much less during a period of grave financial stringency, so long as there exists room for further economy. You should consider it your primary duty to assist your Chief in this important matter, and I trust you will take his advice to heart and will not give him any further occasion for comment on this important aspect of your functions.

Turning to more pleasant subjects, it is a matter for gratification to find that considerable headway has been made since you met last on the technical side in such matters as research into the problems of irrigated plantations, cultivation of mulberry and propagation of *farash*, and in regard to silviculture and forest management. As regards management of forests and their conservation, I was much impressed by

Mr. Parnell's note recorded by him after his visit to the French Forests with the members of the International Forest Conference last summer, which indicated that our methods in these matters were in no way inferior to those employed by the more advanced European countries. I am confident that our Forest Officers will continue to carry on the best traditions of the department and will not only maintain its present efficiency but will continue to strive and achieve further improvements and success on the technical and administrative sides as well as in the domain of research.

[It is proposed as space permits to reproduce some of the papers read at this conference which are likely to be of interest to readers outside the Punjab.—*Ed.*]

EXTRACTS FROM SLEEPER POOL COMMITTEE REPORT AND APPENDICES, 1931-32.

The total amount spent on wooden sleepers on Class I Railways (not including H. E. H. the Nizam's State Railway and the Jodhpur Railway) during each of the last five years has been :—

1927-28	Rs. 281·82 lakhs	including	Rs. 8·67 lakhs	for imported sleepers in India.
1928-29	,, 266·89 ,,	,,	Rs. 2·48	ditto.
1929-30	,, 237·41 ,,	,,	*Nil*	ditto.
1930-31	,, 174·65 ,,	,,	,,	ditto.
1931-32	,, 159·48 ,,	,,	,,	ditto.

It will be seen that no wooden sleepers have been imported from abroad during the last three years.

The purchase of imported wooden sleepers reached its maximum in 1926-27, namely Rs. 24·80 lakhs.

In this connection it is interesting to note that one railway proposes to remove 100 miles of imported Douglas fir sleepers which were laid between 1923—27. A large number have already reached a stage when fast traffic on them is no longer safe, and the remainder are showing signs of deterioration, the rate of which has been found to be rapid with Douglas fir towards the end of its life. Their average life has proved to be about 6 years, which compares most unfavourably with home grown sleepers. These sleepers cost Rs. 6-4 each f. o. r. Indian ports. The soft wood sleepers treated in India have never cost as much as this and have given a longer life. The N. W. Railway who have 800 miles of this track reckon on a life of from 12—14 years.

The relative position of the various kinds of sleepers during each of the last four years can be seen from the following percentages, based on the total number of sleepers of each kind in the track :—

Class I Indian Railways			Wood. %	Cast Iron. %	Steel. %	Other kinds %
Broad-Gauge 5′-6″	1928-29	..	45·8	38·7	15·1	0·4
	1929-30	..	44·2	33·6	16·8	0·4
	1930-31	..	43·9	38·6	17·1	0·4
	1931-32	..	44·0	38·2	16·8	0·4
Difference between last two years		..	+0·7	—0·4	—0·3	..
Metre-Gauge 3′ 3⅜″	1928-29	..	74·5	6·7	18·6	0·2
	1929-30	..	73·3	6·5	20·0	0·2
	1930-31	..	73·3	6·1	20·4	0·2
	1931-32	..	72·5	5·9	21·5	0·1
Difference between last two years		..	—0·8	—0·2	+1·1	—0·1

The total wooden track mileage of all gauges on Class I Railways on March 31st, 1932, was 28,073 miles out of 52,454 miles. The Class II and III railways total about 4,800 miles of track of various gauges and most of this is on wood.

Cast Iron sleepers ordered in May 1931 cost from Rs. 7·44 to Rs. 7·86, complete f. o. r. works, according to type, and the price of steel trough sleepers in 1932 varied from Rs. 7-6-0 to Rs. 8-4-0 f. o. r. works, complete with all fittings.

SLEEPER TREATING PLANTS, DHILWAN, N. W. RAILWAY.

STATEMENT OF TREATING COSTS FOR THE YEAR 1931-32.

Detail.	Sleeper Treated. *Fir.*	*Chir.*	*Kail.*
Total number of sleepers treated during 1931-32 ..	141,398	240,813	73,205
Average absorption of mixture per sleeper ..	14·1 lbs.	14·8 lbs.	14·1 lbs.

Proportion of mixture 40 per cent. Creosote
60 per cent. Liquid Fuel.

Average cost per lb. for Creosote 10·3 pies (exclusive freight).
,, ,, for Liquid Fuel 3·6 ,, ,,

Total Number of Sleepers of all kinds treated during year = 4,55,416.

		Sleepers Treated. *Fir.*			*Chir.*			*Kail.*		
	Cost per Sleeper for Treatment.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.
1.	Cost of Creosote at lbs. per sleeper ..	0	4	10	0	5	1	0	4	10
		(5·64)			(5·92)			(5·64)		
2.	Cost of Liquid Fuel lbs. per sleeper ..	0	2	6	0	2	8	0	2	6
		(8·46)			(8·88)			(8·42)		
3.	Carriage charges on Creosote ..	0	1	0	0	1	1	0	1	0
4.	Carriage charges on Liquid Fuel ..	0	0	9	0	0	10	0	0	9
5.	Cost of Stores ..	0	0	8	0	0	8	0	0	8
6.	Carriage charges on Sleepers to Dhilwan ..	0	5	9	0	8	9	0	3	9
7.	Unloading, stacking and re-loading sleepers at Dhilwan ..	0	0	3	0	0	3	0	0	3
8.	Labour charges including cutting, adzing, boring and handling treated sleepers ..	0	2	6	0	2	6	0	2	6
9.	Depreciation on Stock (Sleepers) ..	0	1	8	0	0	9		..	
10.	Depreciation including interest on Capital ..	0	3	6	0	3	6	0	3	6
11.	Overhead charges ..	0	0	4	0	0	4	0	0	4
12.	Shunting and Miscellaneous Charges ..	0	0	5	0	0	5	0	0	5
	Total ..	1	8	2	1	10	10	1	4	6

The actual cost of treated sleepers including all charges compares as follows :—

	1930-31. Rs.	a.	p.	1931-32. Rs.	a.	p.
Treated *Chir*	5	3	0	5	1	1
,, Fir	4	7	7	4	9	10
,, *Kail*	5	7	1	4	13	0

Naharkatiya, Assam Bengal Railway.

The following are the details of the year's working :—

Species.	*Hollong* and *Hollock*.
No. of sleepers purchased	188,780
No. of sleepers treated	200,320 of which 92,022 were supplied to the E. B. Ry.

Total cost per sleeper—	Rs.	a.	p.
(*a*) Cost of sleepers	2	4	2
(*b*) Creosote ·508 gallons at 11/11	0	5	8
(*c*) Earth Oil ·497 gallons at 3·90	0	1	11
(*d*) Cost of treatment	0	4	8
(*e*) Contingencies	0	1	1
Total	3	1	6

The Chairman in opening the 7th Annual Meeting of the Sleeper Pool Committee, held in the Railway Board, New Delhi, on Wednesday, the 30th November 1930, said :—

Gentlemen, this Committee has not met since July 1930, chiefly because no difficulty has been experienced in obtaining and allotting all the sleepers required during recent years, when the demand both for renewals and construction has been much reduced. The change in the situation is apparent from the fact that whereas in 1927-28 the purchase of B.-G. Sleepers amounted to 28½ lakhs, by 1930-31 it fell to 15 lakhs and for 1933-34, with which we are to-day concerned, the total is only about 14½ lakhs. Based on the total number of wooden sleepers in the line and a life of 15 years the normal demand should be about 19 lakhs.

The demand for M.-G. Sleepers has remained more constant, round about 11½ lakhs, but this again is less than what the normal demand, namely, 16 lakhs, works out at on the basis of the total number in the line. Calculations by this method can of course only give a rough approximation to actual requirements which depend on the date of the last lines constructed.

The position in respect of prices has changed a great deal since we last met. At that time we were placing orders at Rs. 7/- for *sal*, Rs. 6/8/- for deodar, Rs. 8/- for mixed species, and about Rs. 3/- for meter-gauge sleepers. Three-year contracts have been negotiated recently at about Rs. 5/- for *sal*, Rs. 4/12/- for deodar, Rs. 6/- for mixed species, and about Rs. 2/2/- for meter-gauge sleepers. If the normal demand of 19 lakhs B.-G. and 16 lakhs M.-G. is required in future, and if we can, as we expect, meet it at about these rates, future years will show an annual saving of about 60 lakhs of rupees compared with 1930-31.

I notice that my predecessor referred in 1930 to a composition for filling spike-holes in sleepers to prevent "Spike-killing."

This composition has now been patented all over the world by the inventor, Dr. Krishna of the Forest Research Institute, under the name "Fridera." Trials in the line have so far proved satisfactory, the composition having survived two hot weathers in the Punjab. Orders for about 5 tons have been received from most of the Indian Railways, and arrangements for manufacture on a commercial scale by the Jallo Subsidiary Industries Company at Jallo in the Punjab have just been concluded by the Inventor. Orders can now be placed with this Company at the C. & M. Gazette Buildings, The Mall, Lahore.

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FOREST EDUCATION.

We have recently received a copy of a book bearing the above title written by H. S. Graves, Dean of Forestry at Yale University, and C. H. Guise, who is on the Forestry Staff at Cornell. It is published by the Yale University Press at 2½ dollars.

Although this book has been written primarily for those interested in American forestry, it should make a much wider appeal as it forms an excellent summary of the conditions of forestry courses throughout the world. An exhaustive analysis has been made by a Forest Education Inquiry Committee under the auspices of the Society of American Foresters of the teaching conditions in the 25 forestry colleges of university status in the United States and their fitness or otherwise in training men for the diversity of positions which are now classed under forestry. When we read that in the year 1931, 381 forestry degrees of B.Sc. standard and 92 of M.Sc. standard were awarded and that the number of forestry students enrolled in that year totalled 2,258, one begins to wonder how these men are all going to find employment. It is partly the question of finding employment which has called forth this inquiry, and following the lead of a similar British Committee, a reduction in the number of schools is recommended. One striking fact brought out in these statistics is that out of the large number of men who start these courses quite 50 per cent. drop out and fail to finish or obtain a degree.

Emphasis is laid upon the need for a higher standard in English and particularly in the writing of reports,—a point which we consider has been sadly neglected in both British and Indian courses also,

Pertinent criticism is also made of the frequent lack of preparation and method in leading students' field parties, which might equally well be applied nearer home. "The field lecture . . . requires exceedingly careful planning and preparation on the part of the instructor. A poorly organised excursion may be worse than an ill-prepared class room lecture, for it represents a greater loss of time for the student."

It is a little difficult to compare the American schedule of lecture hours for their usual 4 years' forestry course up to the B.Sc. standard with our Indian courses, as practically the whole of the first two years is devoted to general science, mathematics and English, while in the case of the I. F. S. class these are supposed to have been fully covered by students in their previous studies. The authors are very emphatic however upon the evil results of leaving the whole of the teaching in the hands of one or two lecturers who have to cover a multitude of subjects and inevitably become inefficient jacks of all trades with little opportunity of keeping abreast of the contemporary literature for the subjects they are responsible for. They emphasise that lectures to be effective should not be mere dictation but should serve to interpret the principles and acts in the subject, thus aiding the student in his personal study. Definite time should be allotted for the student to do his own reading, and this is a point which we consider should be attended to in most of our forestry courses, which tend to develop into a too highly organised orgy of cramming lecture notes. "Hasty fact-cramming over a wide range of subject matter, too often merely factual and descriptive, thus usurps the time that should be used for concentrated discipline in relatively restricted fields."

The effect of the recent rapid development in forestry research methods in the United States has already had a marked influence in raising the standard of forestry education.

"The Forest Service research organisation . . . . . . seeks and obtains men of outstanding intellectual and personal qualifications with special background, equipment, and aptitude for research and special ability for clear-cut and forcible scientific writing. It recognizes that forestry is a technical field and that its advancement is closely bound up with the creation of the highest technical and pro-

fessional standards. It lays stress also on the personal qualifications of recruits, frequently taking men who have already demonstrated desirable personal qualifications by success in administrative work. In nearly all appointments, the master's degree is essential, and the Branch frequently sacrifices immediate results by encouraging its men to take leave for advanced work of doctorate grade. Moreover, the Branch maintains contact with younger students of promise who are preparing to enter research work and advises and assists them. As a preparation for forest research, therefore, it is important that the student have not only the customary preparation in general education and in forestry, but an unusually thorough background of general science, thorough preparation by graduate work in his own field, such as silviculture, ecology, products, or forest economics, and special equipment in research methods, including modern statistical analysis. For success in forest research, as in other fields of science, the scientific worker must have, in addition to intensive preparation, a genuine aptitude and liking for research and the qualities of scientific patience and imagination. For men with such qualities and such preparation, forest research offers an attractive field for creative and original work."

The authors are greatly in favour of the European practice of giving each student a thorough practical training in outdoor forestry work such as is done in Prussia and Sweden, similar to the $3\frac{1}{2}$ months' initial training for the Dehra Dun Rangers, before they embark upon their lecture work. They refer to the Swedish system of a year's field practice at Garpenberg as being of unusual interest. Garpenberg has excellent facilities for all forms of woodsmen's employment such as sawmills and pulping mills, in addition to the routine work in the nurseries, plantations, and felling areas of an intensively managed forest district. This beginner's year is divided into a summer term on forest survey work followed by the rest of the year on practical silviculture, mensuration, and a variety of subjects such as office technique and ski running, with a daily schedule of classroom and field work from 8 a.m. to 6 p.m. maintained under a most vigorous discipline. It is only on the basis of rigid tests of mental and physical

fitness at the close of this year's training that students are selected for a further two years' course in the forest high school at Stockholm.

One rather surprising recommendation is that in the study of foreign languages the most useful to American foresters are placed: first, German; second, Swedish; third, French. This is presumably because the Swedish forestry technique with its specialisation on conifer forests lying in the climatic belt of heavy winter snowfall, and the Swedes' rapid development of their timber export and pulping mills are more likely to be of direct application in the United States. For Indian work French is unlikely to be displaced as the favourite alternative language because the French regeneration problems and the development of their tropic and semi-tropic colonial forests are more nearly parallel to Indian conditions. If the question is to be decided by weight of numbers, however, we shall all soon be "swotting" Russian, because they have 11 forestry schools in one of which, Leningrad, there are approximately 3,000 students!

AIDED NATURAL REGENERATION OF *HOLLOCK* (*TERMINALIA MYRIOCARPA.*)

By A. R. Thomas, I.F.S.

[*A reply to the article* " *Scrap the Lot* " *which appeared in the Indian Forester for October* 1932.]

The writer has no wish to usurp the prerogative of our giant uncles and cousins in the United Provinces and the Punjab, or of the immortals, so aptly described by Mr. Martin in his article "Scrap the Lot" in the *Indian Forester* of October 1932, by making any reply to, or criticism of, the excellent and witty article in question, but the writer feels that, while he agrees absolutely with 99 per cent. of the sentiments expressed in the article itself, and while he admires Mr. Martin for having the courage of his convictions and putting them on paper, the golden rule of life, *i.e.*, that the exception proves the rule, should be applied in this case also, inasmuch as recent excellent and cheap results in attempting aided natural regeneration of *hollock*

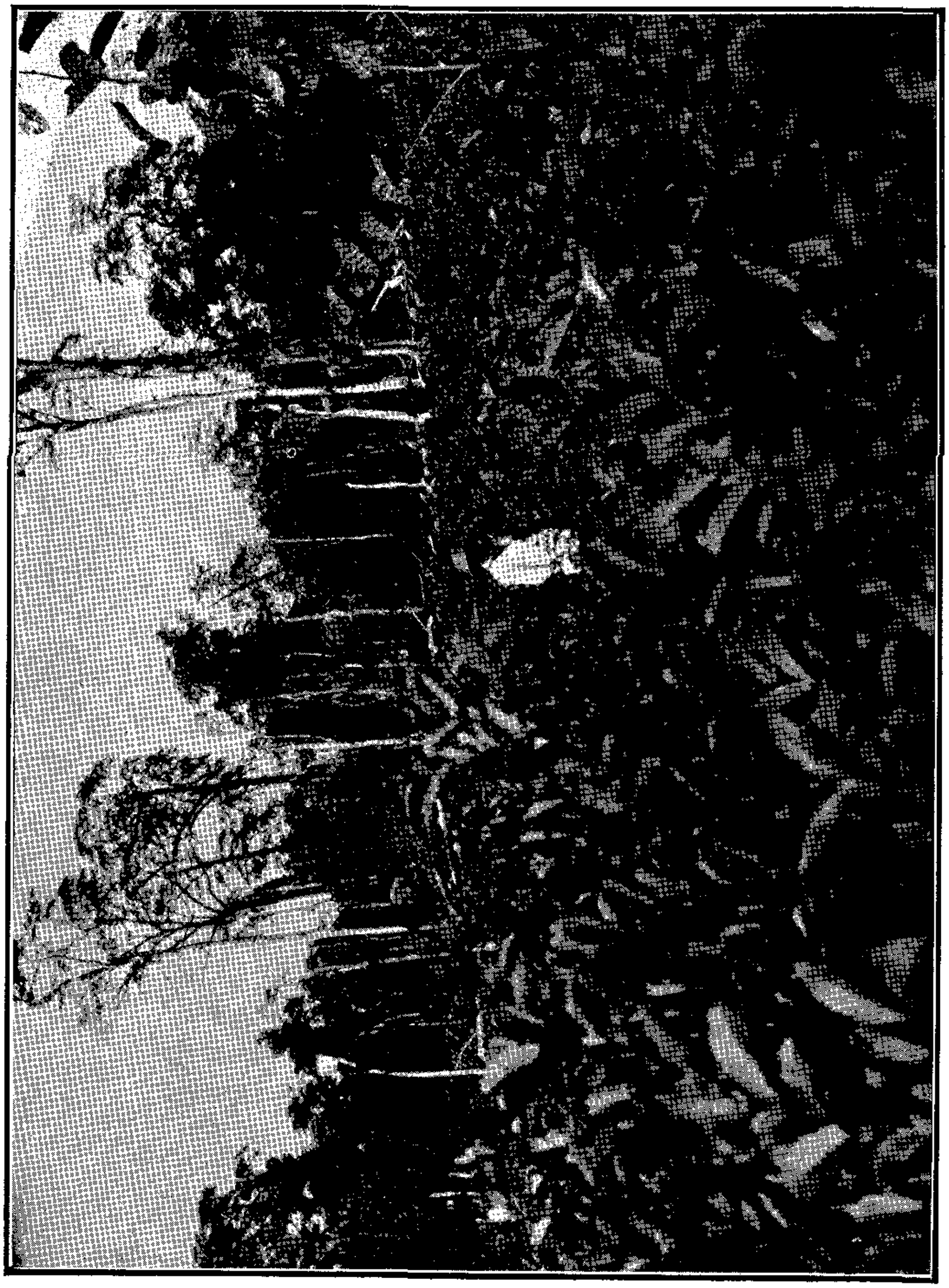
(*Terminalia myriocarpa*) in Mr. Martin's old division, the Sadiya Frontier Tract, have now reached the stage when they can safely be exposed for admiration to the public gaze. Mr. Martin has, quite rightly, described the plains evergreen forests of this district as being the best in Assam, though this description is not applicable to the whole district. The writer would go further and say that the particular plains forests where aided natural regeneration of *hollock* has definitely proved successful, known as the Pasighat Protected Forests, (protected for political reasons as well as in the interest of silviculture), are probably amongst the finest and richest in India. That is, however, as may be, and the writer has no wish to argue the point as his own personal experience is limited to Assam.

The writer has stated above that he agrees with 99 per cent. of Mr. Martin's sentiments in regard to scrapping the various and somewhat inconsequent efforts which have been made in Assam in the past to establish natural regneration in some of our evergreen forests. As far back as 1919 the writer had already come to the conclusion that the only satisfactory method of regenerating our evergreen forests was by artificial plantations, but this was just after the war and the writer was far too diffident at the time. He had only just been demobilized and, prior to joining up in 1915, had only had a little over 3½ years' service in the department to do more than write a private note, for his own edification, on the subject. Well, the writer considers that the results of aiding natural regeneration of *hollock* in the Pasighat Protected Forests, from the cold weather of 1931-32, may at least be taken to represent the extra 1 per cent., thus providing the exception which proves the rule. After the above preliminary remarks the writer can now "cut the cackle" and get down to a description of what has actually been done in the Pasighat Protected Forests.

In March 1931, as the result of a preliminary inspection by the Conservator, Mr. Owden, and in accordance with his instructions, a quadrant experiment was initiated in the Pasighat forests (in an area previously exploited by the Assam Sawmills and Timber Company, Limited). Two solitary healthy *hollock* trees, which had originally

been selected and kept as seed bearers, without any assistance being given were again selected and lines were cut, the centre line on a bearing of 175°, radiating out from each tree, as a pivot, thus forming two quadrants. The external arms were each 450′ long and 20′ wide, and the extremities were connected by an arc, also 20′ wide, while two arcs, each 20′ wide, were cut across the quadrant at points distant 150′ and 300′, respectively, from the pivot tree; subsidiary lines, each 20′ wide, were further cut connecting the intermediate arcs with the circumference. The object of these experiments was to determine the wind direction.

When the writer who joined the division in October 1931, first visited the quadrants in November 1931, he found that the natural regeneration of *hollock* in all the lines (except in a few water-logged places), was then about 9 months old, and was so profuse and magnificent that it was difficult to decide the exact wind direction, but the best results were noticed on lines cut on a bearing of between 165° and 175°. It may be added here that each line had been carefully weeded a little before seedfall in the latter part of January 1931; trees standing in the way of seed dissemination had been felled and the soil had been wounded by the dragging of a heavy root up and down the lines by departmental elephants. The Conservator had given instructions that, in order to regenerate, by aiding nature, the area exploited by the sawmills during 1931-32, this area should be divided by lines 450′ apart containing mother trees (and, in parenthesis it may be stated that the *hollock* stand in the Pasighat Felling Series is so amazingly rich that it was possible to select a series of mother trees 50′ to 100′ apart literally, or so literally as to make no difference, along 7 straight lines) on a bearing of 265°, each mother line to be connected to the other by lines 20′ × 40′ on a bearing of 175° (this being taken to represent the main wind direction as a result of the quadrant experiment above referred to). The writer was so impressed by the result of this experiment that he got permission to clear-fell the first of the 6 sub-blocks which resulted from the cutting of the 7 mother tree lines, while 2 of the next sub-blocks were connected by lines. Actually, owing to general trade depression and lack of orders, the sawmills



A general view of the clear-felled area, after one growing season.
Thomas, Natural Regeneration of Hollock.

A view of part of the area clear-felled during 1932-33, showing two mother-tree lines 450 feet apart. Note the straightness of the mother lines.

Thomas, Natural Regeneration of Hollock.

were only able to exploit 3 sub-blocks, instead of the 6 meant to be exploited, so that our regeneration work also had to be confined to the first 3 sub-blocks, an area of 64 acres in all. *Hollock* being a species which requires attention, weeding, etc., from the actual germination stage, strict orders for this to be done carefully were issued, and the writer spent a good part of the spring and rains of 1932 in seeing that this was done. The writer would like to interject here the fact that when Mr. Cooper, who was Conservator at the time, inspected the quadrant experiment in February 1932, it was difficult to convince him that the lines had not been sown, in fact he challenged the Range Officer with pulling his and the writer's leg! However he was eventually convinced, and expressed himself as completely satisfied with the result of the experiment, and as being very hopeful of the results of the work then being done in the clear-felled area and other two sub-blocks for 1931-32. And he was fully justified.

During inspections made in the middle of the rains (and it *can* rain at Pasighat, situated as it is at the foot of the Abor hills) excellent results, not only in the lines, but also in the clear-felled area, were found. During a recent inspection made after the rains were nominally over magnificent patches in the clear-felled area with occasional stems 8′ and 7′ and over in height and one stem actually over 9′, the average being about $5\frac{1}{2}'$, were found. Three complete weedings up to the middle of September were made, and a fourth partial weeding only, in a few lines and in places in the clear-felled area, has just been completed (November 1932), but the main attention which the whole 64 acres will now require, for a year or so, is climber cutting, particularly the ground creepers which shoot out from the edges of the jungle between the *hollock* lines and which are extremely difficult to cope with and do endless damage.

The only soil preparation done over most of the area, was clearing the jungle close to the ground (this was commenced during the last week of December 1931) and subsequent wounding of the soil by means of dragging heavy *otenga* roots all over the area by the departmental elephants. In a few lines, where germination was less on account of the mother trees not being so conveniently placed, broadcast sowing was done after hoeing, with the rather startling effect

that best results were found in lines which had merely been cleared close to the ground and on which plenty of natural seed fell and which had not been hoed or sown. This may possibly be due to the fact that the roots of the seedlings get a better grip in the sandy friable soil if this is not completely turned over by hoeing, but be the reason what it may, this fact considerably cheapens the whole operation.

Another point which requires to be brought out is the very great assistance given to the operation by means of the various dragging paths, created over the whole area by extraction of logs by sawmill elephants. Although the point has been argued that it is advisable to work one year in arrear of the sawmills, to avoid the rush just when germination is taking place, the writer has always contended that this rush can largely be avoided by a system of give and take and personal supervision, by providing definite dragging paths for sawmill use at the time seed is falling, and his contention has been more than borne out by the results of the 1931-32 operations. From the very commencement of germination, growth along these dragging paths, and particularly along the edges, has been good, and some of the best results are now found in these places. In certain lines where germination was poor, but where dragging paths crossed them, the growth along the path is outstanding. All this would be lost if we work a year in arrear of the mills, as, if not weeded and tended *at once* from germination onwards, the seedlings would very soon be smothered by weed growth, particularly *Gynura angulosa,* a kind of groundsel, which is a regular pest, being perennial and ubiquitous. Mr. Martin in his article refers to the Proceedings of the Silvicultural Conference in 1929 and states that Assam at that time was on a par with other provinces as regards natural regeneration in evergreen forests, explaining this to mean that no start had yet been made with this problem. The writer hopes that the above remarks will prove that Assam has definitely started, at least in the rich *hollock* forest just described, and that, in this respect, Assam may be said to be pointing the way. The writer reiterates once more the excellent quality class of the Pasighat forests as it is only fair to do so, but the fact remains that in these particular forests at least, the formation of *hollock* forests by aided natural regeneration has been achieved.

A line 20 feet wide connecting mother-tree lines : aided natural regeneration, one growing season old.
Thomas, Natural Regeneration of Hollock.

A bird's eye view of one of the original quadrants referred to in the article. The large tree in the centre is the mother-tree from which radial lines were laid out, as seen. Two growing seasons.

Thomas, Natural Regeneration of Hollock.

The cost of the operation over 64 acres from commencement in December 1931 up to and including the partial fourth weeding which was found to be necessary in November 1932, works out as follows :—

	Rs.	a.	p.
(1) Jungle clearance to ground level, from 23rd December 1931 to 15th January 1932; clearance of mother tree lines; logging and removal by departmental elephants of species other than *hollock* which the sawmills refused to take; preparing *otenga* roots to be dragged by elephants; transplanting; burning on a small scale (this burning in the lines was not very effective, and failure to rake away the ashes after burning resulted in blank patches where no germination occurred); hoeing and sowing in 16 lines; erection of seed shed and seed collection ..	423	13	3
(2) Three complete and one partial weedings over whole area	547	7	9
Total expenditure, 64 acres ..	971	5	0
Cost per acre, approximately ..	15	2	0

Even allowing for the fact that departmental elephants were utilized for removing *débris* and logs from trees which had been felled and subsequently cut up departmentally, which were not taken by the sawmills, and also for the fact that the little sowing that was done (9 acres only) was done by forest officers, mainly guards, the cost per acre compares very favourably with that of Mr. Martin for departmental plantations, in that he is able to sell all his firewood (operations apparently only being undertaken where firewood can be sold), and has not to deal with the departmental removal of large evergreen species which will not burn and for which there is no market, as has to be done in Pasighat. This latter fact may be set against the amount of Rs. 18/- per acre which covers the period of 3 rainy seasons according to Mr. Martin's figures, while figures for creation and maintenance up to

and including a partial fourth weeding in the Pasighat forests works out at about Rs. 15/- per acre for one growing season. Moreover, Mr. Martin's figure of Rs. 18/- per acre includes no expenditure on weeding or climber cutting during the 2nd and 3rd rains, neither of which operations can be neglected at Pasighat. Finally, regeneration by nature has the advantage, and a very great advantage it is, of seed falling to the ground at the psychological moment. Providing the soil is ready to receive the seed, it is a commonplace that seed falling thus is likely to give better results than seed which has been collected and kept, though in the case of certain species this is, of course, not so important. We have not yet reached the stage when, in the writer's opinion, actual thinning should be introduced. The writer however agrees with Mr. Martin that no regular thinning should be done for the first 3 years, but this is a vexed question and requires considerable thought and experiment.

By the way, the policy to be adopted for regenerating the exploited areas this year, will be to clear-fell *all trees* other than species which will be taken by the sawmills, and after this, clear the jungle to ground level in lines, probably $40' \times 20'$.

The writer feels that he must once more lay emphasis on the fact that we are undoubtedly dealing with an exceptionally fine stand of *hollock*. During the 1931-32, 601 *hollock* trees totalling 165,498 cubic feet of serviceable timber were removed by the mills. This works out at 9·4 trees per acre and 275 cubic feet per tree, or, in other words, an average of 2,588 cubic feet per acre, roughly 10 times the quantity mentioned by Mr. Martin in his article. This year the writer has already measured 227 trees from the current year's coupe averaging 232 cubic feet per tree of sound timber. *Hollock* grows in well-defined belts and just at present work is going on in the centre of what is probably the richest belt of this species in India, or anywhere else. It is hoped that a working plan for these *hollock* forests will be in operation from 1934. The Working Plan Officer is hard at his work now, having commenced last cold weather, and it is obvious that, if the future is to benefit from the existing rich crop a working plan must be introduced as soon as possible.

The writer feels that this article will be criticised, because he is dealing only with a special area, but he only set out to prove that, given suitable conditions and necessary supervision, natural regeneration is possible in Assam. Similar belts of *hollock* though not so rich, are to be found in other forests in the Sadiya Frontier Tract, and though the writer is at present concentrating natural regeneration only in the Pasighat forests, it is to be hoped that the Working Plan will prescribe similar treatment elsewhere, once the present financial crisis has come to an end.

Since commencing this article, the Inspector-General of Forests has found time to inspect the area in question, and was kind enough to express himself entirely satisfied with the results achieved. Incidentally, also the writer found a stem 10′-6″ high only recently in the clear-felled area ; not too bad for about ten months' growth !

THE PRACTICAL VALUE OF LABORATORY SHRINKAGE DETERMINATIONS.

BY L. N. SEAMAN, OFFICER-IN-CHARGE OF TIMBER TESTING, F.R.I.

There is frequently a tendency to regard the results of laboratory experiments as theoretical in nature, and of doubtful value in practical application. It cannot be denied that some items of research work seem to justify this view. Results obtained may not be reproducible in large scale operations or may be too costly to be applicable in commercial undertakings. This, however, should not be taken to indicate that the value, even of the most theoretical research work, is doubtful. On the contrary most of the important advances of recent years have had their inception in the laboratory of the scientist. Discoveries and inventions which at first appeared to be of academic interest only have, with further research, proved to possess the broadest and most practical application.

Besides results of this kind, however, large volumes of laboratory data are obtained suitable for immediate application to everyday practical problems. This is pre-eminently true of data collected in Forest Products Laboratories, where it is often impossible to devote

time to the investigation of fundamental problems on account of the pressing demand for data derivable from purely routine investigations. Seasoning schedules must be prepared, and strength data tabulated for immediate use, and research along lines which are, for the present, of purely academic interest must wait for the time when data from routine testing are reasonably complete, and producers and consumers alike are in possession of those facts and figures which have an established application in the economic utilization of timber. It is for this reason that so large a proportion of the time of the Timber Testing Section of the Forest Research Institute at Dehra Dun is still devoted to the projects in routine testing, Project No. I for small clear specimens and Project No. II for structural timbers.

It is the practice to record as fully as possible, in connection with routine projects, all pertinent observed data relating to the physical as well as to the mechanical properties of the wood. Among such observations are those for shrinkage. Shrinkage determinations are made according to standardized methods and are arranged to yield data relative to reduction in volume, and linear reduction in the radial and in the tangential directions of the seasonal growth layers of the wood. The specimens used in volumetric determinations are 6 inches long in the direction of the grain, and of 2 inches square cross section. The volume is measured by the water displacement method, suitable precautions being taken to prevent error due to the absorption of water by the specimens.

The linear shrinkage determinations are made with specimens of *1 inch square cross section and as nearly 4 inches long as the material* will provide. In this case the *length* of the specimen is taken in the direction in which the shrinkage determination is to be made, *i.e.*, a radial shrinkage specimen is 4 inches long in the direction of the wood rays, and a tangential shrinkage specimen 4 inches long in the direction tangent to the growth rings. Measurements of linear shrinkage are made with a micrometer gauge.

Shrinkage determinations of the nature just described belong to the category of laboratory experiments, and it is necessary to ascertain whether or not their results have a practical application. Tests have

consequently been made to elucidate some of the relations between the results obtained with these small laboratory specimens and the shrinkage actually encountered in practice. The data thus collected, though still incomplete, throw an interesting light on the actual value and correct practical application of the results obtained by the laboratory methods.

The first question to be investigated was whether or not laboratory shrinkage values were constant and reproducible or whether they were subject to variations resulting from differences in manipulation. An interesting indication in this connection was available from abroad in the report of the United States Forest Products Laboratory that specimens dried by different methods, at different times and in different parts of the country gave results that were remarkably concordant. This report was, however, based on work with softwoods only. Experiments made more recently by the Timber Testing Section at Dehra Dun employed thirty-five species representing both softwoods and hardwoods. In this work standard specimens were used, but variations in temperature and ventilation of drying ovens, far wider than could possibly be encountered in the ordinary course of events, were purposely introduced. It was found that these exaggerated variations of oven conditions had no important influence on the observed shrinkage value, and the experiments verified the American report, and extended its application to hardwoods.

It must not be inferred from the above paragraph that it is impossible to influence shrinkage by oven manipulation. On the contrary it is known that quite wide changes in shrinkage *can* be produced by suitable control of drying conditions. All that these experiments prove,—but it is quite sufficient for the purpose in view,—is that standard laboratory methods yield very constant, reproducible results, and that variations in manipulation much wider than those that are likely to occur in practice have no serious influence on the observed results.

Laboratory observations for shrinkage being consistent and largely independent of oven manipulation, it is desirable to know what

relation they bear to the actual shrinkage of larger pieces, the shrinkage which is encountered in all practical uses of wood. That they afford a strong indication of the relative ability of various species to keep their shape after manufacture is beyond doubt. A list of well-known species arranged in order of popular preference, based on practical experience of their shape retention, agrees closely with a list of the same species arranged according to the results of laboratory shrinkage tests. A closer agreement is obtained when those species which have a relatively small difference between radial and tangential shrinkage are moved to slightly higher, and those with an abnormally large difference in this respect to lower places, in the list prepared from laboratory tests.

There seems to be no valid reason to doubt that the less known species can similarly be classified as to their shrinkage behaviour by means of laboratory data. Tests of a few species at Dehra Dun indicated that there was a striking agreement between the results observed with laboratory specimens and the shrinkage of inch boards properly piled. At first the shrinkage of the boards was less than that of the small samples, which is only to be expected. With the lapse of time, however, this difference grew less, and after about two years it practically disappeared. It was further found that the average shrinkage of thoroughly *air dried* material under climatic conditions prevailing at Dehra Dun was just over 50 per cent. of the shrinkage observed for *oven dried* laboratory specimens. For practical purposes no important error will be introduced if the shrinkage of air dry stock about one inch thick is taken to be half the value published as "*Shrinkage, Green to Oven Dry*" (*vide* printed Timber Strength tables).

During the progress of the shrinkage experiments, part of the material was prepared near the end of the hot season, and part towards the close of the monsoon. It was found that specimens, large and small alike, which started their seasoning under very humid atmospheric conditions shrank slightly more than those which were first piled under drier conditions and that the difference persisted after oven drying. The discrepancy was very slight but very consistent, and was the same in one inch boards as in small test specimens.

It is not claimed that any finality has been reached in the study of timber shrinkage. Some very useful indications, however, are available from the data already collected.

(*a*). There is a very close agreement between laboratory results obtained with small test specimens and the shrinkage of boards about one inch thick. Further study is necessary to determine whether or not this agreement holds good for thicker stock.

(*b*). The shrinkage of one inch boards dried to about 12 per cent. moisture content can, for practical purposes, be taken as half the shrinkage of oven dried test specimens, that is, half the values published as "*Shrinkage, Green to Oven Dry.*"

(*c*). No appreciable error is introduced by variations of oven conditions encountered in ordinary laboratory practice. Indeed it has been found that oven conditions purposely varied over a much wider range than might reasonably be expected cause no noticeable change in test results.

(*d*). When specimens or boards are piled for seasoning under abnormally humid conditions, they shrink slightly more than when the drying is started under drier, more normal conditions. For the climatic variations prevailing at Dehra Dun, the difference is very slight. In the species examined by the Timber Testing Section at Dehra Dun, the variations in one inch boards were practically the same as those in small test specimens.

BRANCHING OF TEAK IN PLANTATIONS.

By Rai Sahib J. K. Pande, Forest Ranger.

It has been noticed in the Lakhmanmandi plantations in Haldwani Division that the teak plants have a growing tendency to develop forks or thick side branches, both in direct sowings and in root and shoot cutting areas. An appreciable number of plants form forks or thick branches thus wasting the vigour of the plant in producing 2 or 3 thin stems instead of growing into one vigorous stem. In several cases the forked ones form 3 or 4 stems but generally they are biforks each of which have a tendency to fork again higher up.

In the areas sown or planted in 1927, 1928, 1929 and 1930 forming pure as well as bamboo mixed plantations this feature is very noticeable. In the case of single stems the lower branches frequently become comparatively thick and persist instead of drying up and falling off as is noticed in the case of other ordinary single stout stems.

The origin of this abnormal behaviour of teak plants forming forks or thick side branches has, it seems, not so far been traced. Forking may be attributed to light frost attack on the leading shoot or to withering or check in growth, or to some other cause such as the abrupt stoppage of the circulation of sap for some reason such as drought or anything acting as a 'whip' because the leading shoot of teak is very intolerant of irritation of any kind. But abnormal branching and sending out comparatively thick side branches which persist and go on growing as rapidly as the main stem, thus reducing the rate and vigour of growth of the main stem, is quite a new thing for U. P. where teak plantations are still in their infancy.

One cannot say that it is due to insufficient light, because this extraordinary behaviour of teak plants was found in pure teak sowings as well as in teak mixed with bamboos at a spacing of $8' \times 6'$, and in teak poles having attained a height of 30 to 40 feet.

This forking and branching of teak poles seems to be a defect which may reduce the volume of timber expected from these areas if teak plantations are to form successful forests. It may result in large casualties due to windbreak and some means must be found to combat it now when the plantations are still in their infancy.

The only obvious and simple way to deal with forks seems to be to cut out all thin forks and leave one stout stem. But very often one has to think twice before he decides which of the stems is to be cut out when he finds both or all the forks growing equally vigorously. Of course in the case of thick branches one can easily say that the thick side branches growing abnormally may be pruned but in several cases the lower branches are quite normal and therefore not requiring pruning, but when the plant has reached a height of 10 to 12 feet one finds ordinary branches developing into abnormally thick branches, the main stem getting thinner and sometimes being broken by wind,

One might say that such abnormally branched or forked plants may be thinned out in the 1st or 2nd thinnings but in actual practice it is often found that the tree to be taken out on grounds of equal distribution happens to be the very tree which is most worth retaining, and if we take out only the branched or forked trees the equal distribution of future stems is disturbed.

Any practical suggestions in the way of stopping the tendency of the teak plants producing inconvenient forks when they are still young, would be very welcome at this stage.

KANDI (*PROSOPIS SPICIGERA*) FORESTS IN SIND.

By B. B. Wadhwani, Forest Ranger, Ghotki, Sind.

In Sind *kandi* forests are confined to inland and arid areas, where the River Indus floods very seldom if ever reach. It is a well-known fact that the annual rainfall in Sind is very scanty and by itself alone quite insufficient to sustain tree growth. How these forests came into being is thus obscure; the one probable solution is that at one time, beyond the recollection of the present generation, these areas were in receipt of river floods, when *kandi* established itself. This species is a "die-hard." Once it establishes itself, its long taproot penetrates deep down to tap the subsoil moisture; and then, when a tree is eventually felled, the species produces coppice shoots in great abundance like so many bamboo clumps. The growth of the coppice is so fast that within a couple of years the shoots get beyond a man's height.

Rotation—The forests are worked on a rotation of 30 years. The wood is used for fuel. Charcoal is manufactured in very small quantity. Its timber use is only for agricultural implements and huts. The wood is subject to a very serious attack by white ants. This insect has been found attacking even standing semi-moribund trees in such shallow, sandy soils as haven't received water for some years past. Damage by a species of borer is another menace; within 4—5 months of felling the billets are attacked. Trees cut during September are said to be immune from this attack, while those cut later up to March are less liable than those felled after this.

Propagation.—As aforesaid, the species coppices very profusely and consequently no serious attempt has been made in the past at direct sowing. Exploited coupes are given for one or two years' cultivation, in which case the ploughing wounds the lateral roots and induces the growth of root-suckers. Blanks are stocked by *agri-cum*-forestry methods. Lately, however, in such high coupes as are out of reach of artificial irrigation which precludes cultivation, a new process has been introduced by Mr. N. C. Ramchandani, D.F.O., Sukkur, which comprises digging with a spade or an adze two concentric rings round the stool of the felled tree to a depth of a few inches. The idea is to wound the lateral roots in order to induce the production of root-suckers. This has given good results. The reason why direct sowings have not been attempted in the past is because of the impression prevailing here that they never succeed.

Results of Direct Sowing.—We had very high floods in the River Indus last year. The forests of my Range, Ghotki, which are on a high level, started getting water in the first week of August 1932 and remained under water for about a fortnight. Just when the flood was on the ebb, I broadcast *kandi* seed in the felled coupes of the year. Later on, after the areas were dry enough to permit a man to pass along, dibbling more seed was done with a spade. A pit about 3—4 inches deep was dug, the earth being thrown out. The bottom of the pit was loosened and this loose soil left inside the pit. 3—4 *kandi* seeds were thrown into the pit and covered. The dibbles were roughly 6 feet apart. Germination started after a week and continued for about 10 days more. Practically all the pits were successful; the failures were chiefly confined to higher levels which had not the requisite degree of moisture. Seed sown broadcast had also germinated, but the success was only about 30 per cent. In this way I sowed 387 acres comprising coupes of 1931-32 and blanks with 14·5 maunds of seed, *i.e.*, 1·5 seers per acre.

When the Conservator of Forests, Sind Circle, (Mr. C. E. L. Gilbert) came round to see these areas on 7th December 1932, the percentage of failure was hardly 5. I see no reason why this sowing should not grow into a full crop, if nothing untoward happens. However, I entertain

some apprehension lest the seed should die of drought in the event of its getting no moisture in the following season. If only it survives the next hot season, its continuance will be more or less assured. No preparation was given to the seed apart from the fact that it was collected from cattle pens. The soil where these sowings were done, has 1 foot 9 inches depth of clayey loam on sandy subsoil.

Thinnings.—A word is necessary about thinnings also. The operation was not being done here in the past, but last year, as an experiment, one compartment of 75 acres was thinned. The crop was 19 years' old coppice. The yield from thinnings was 33,894 cubic feet of fuel or 678 cubic feet per acre of fully stocked area. The material was sold at a net royalty of Rs. 12/- per 1,000 cubic feet. By means of such thinnings we may eventually be able to reduce the rotation to 20 years. The thinnings are also expected to yield another advantage, because it is hoped that the coppice shoots from the stools of the thinned trees will form an understory, which, after the removal of the overhead crop, will replace it. The species can stand shade to a very great degree, hence the marking of thinnings is a very hard job for the marking officer, who has to crawl through thickets of side branches which persist very near to ground level.

INDIAN *WENDLANDIAS*.

By C. E. Parkinson, Forest Botanist, and Mukat Behari Raizada, M.Sc., Forest Research Institute, Dehra Dun.

In a recent number of notes from the Royal Botanic Garden, Edinburgh (Vol. XVI, No. LXXX, October 1932), Dr. J. M. Cowan has systematically revised the genus *Wendlandia*. In this revision some new species have been described and changes made from the classification adopted by J. D. Hooker in the Flora of British India and by Brandis in Indian Trees, the works which have chiefly been followed in the preparation of local Indian Forest Floras. This genus is of some importance and interest to Forest Officers in India but as the Journal referred to is ordinarily not available to them the results of

Dr. Cowan's most useful work are here summarised, as far as the Indian species are concerned, for the benefit of Forest Officers and others who may wish to identify the Indian *Wendlandias.*

Dr. Cowan's work, which is here frequently quoted *verbatim,* is much to be appreciated for it has simplified the naming of the species which up till now has not been a simple matter. Some, like *Wendlandia angustifolia, W. coriacea* and *W. glomerulata* are well-defined and geographically distinct, while others, like *W. tinctoria,* comprise a complex of widely distributed variable forms which have hitherto been much confused but are now sorted out into fairly constant geographical forms. Six species, *Wendlandia amocana, W. andamanica, W. burkillii, W. gamblei, W. sikkimensis* and *W. speciosa* are described as new.

General Characters of the Genus.

The *Wendlandias* belong to the family *Rubiaceae* and number in all nearly 60 species, chiefly south-east Asian, of which the 24 Indian species are dealt with here. In habit they occur as dwarf or prostrate alpine shrubs (Chinese species) and range from low shrubs to shrubby, small or large trees attaining in the case of the Malayan tree, *Wendlandia arborescens* Cowan, 80 feet in height. The Indian species are normally shrubs or small trees. The leaves are opposite or rarely ternately whorled with interpetiolar stipules of two kinds, triangular with pointed or cuspidate tips or rounded with a foliaceous reflexed tip. This distinction between the cuspidate and round form is of considerable diagnostic importance.

The inflorescence is a terminal thyrsoid or panicled cyme bearing bracts and bracteoles of variable shape and size. The calyx is comparatively small and varies considerably both in shape and hairiness. The length of the lobes relative to that of the lower connate portion (the receptacle) and the hairiness are useful diagnostic characters. The corolla is either tubular or funnel or salver shaped and the length of the corolla lobes in proportion to that of the tube is a feature of some importance since the tube may be anything from one to eight times as long as the lobes. In most species the corolla tube is

hairy within and glabrous outside but the variations in this character that may be present are not considered of any great importance.

The stamens are very distinctive and constant in character and generally form two types which are relatively easy to distinguish. The anthers may be small and ovoid or elliptic (about as broad as long) or they may be linear or oblong (several times as long as broad) and it has been observed that generally the short kind of anthers are sessile or subsessile and the long kind have relatively long filaments. There are some exceptions to be noted here, *Wendlandia glomerulata* Kurz, having much exserted ovoid anthers and *W. coriacea* DC., *W. gamblei* Cowan, *W. heyneana* Wall. and *W. angustifolia* Wight having almost sessile linear or oblong anthers.

The style, which is always exserted, may be quite glabrous or, as in *Wendlandia ligustrina* Wall. and *W. speciosa* Cowan, sparsely and distinctly hairy. The lobes of the bifid stigma vary in shape and size and one species *W. pendula* DC. is noteworthy in having an undivided club shaped stigma. The capsule is small, globose and usually 2-valved with many compressed and obscurely-winged seeds.

Classification of the Genus.

The classification of the genus is based chiefly on the important characters of the stamens and stipules. The former divide it into the two series Euexsertae and Sub-inclusae and the latter sub-divide these into the sub-series. In plates XIX and XX these characters are figured for nearly all the Indian species. The figures are all from Cowan. The distribution of the genus in India is shown in the appended table.

DISTRIBUTION OF THE GENUS *WENDLANDIA* IN INDIA.

Species.	Ceylon.	Tinnevelly.	Western Ghats of Mysore; Nilgiri, Shevaroy and Anamallai hills.	Western Ghats of Bombay and Kanara.	Eastern Ghats.	Central Provinces; Bihar and Orissa.	North-West India; Punjab to West Nepal.	East Nepal.	Sikkim.	Bhutan.	Bengal including Chittagong.	Assam, Khasia and Naga hills. Manipur.	Upper Burma.	Lower Burma.	Andamans.
bicuspidata	X														
angustifolia	..	X													
thyrsoidea	..	..	X	X	X										
exserta	..	..	..	X	X	X	X	..	X						
tinctoria	..	..	..	..	X	..	X	X	X	X	X	X	X	X	
sub-sp. floribunda	..	..	..	..	..	..	..	..	..	..	..	..	X		
sub-sp. cinnamomea	..	..	..	..	X										
sub-sp. orientalis	..	..	..	..	..	..	..	..	..	..	..	X	X	X	
appendiculata	..	..	..	..	..	..	..	X							
gamblei	..	..	..	..	X										
heyneana	..	..	..	..	X										
puberula	..	..	..	..	..	..	X								
coriacea	..	..	..	..	..	..	..	X	X	..	X				
pendula	..	..	..	..	..	..	..	X	..	X	..	X			
sikkimensis	..	..	..	..	..	..	..	..	X	..	X				
wallichii	..	..	..	..	..	..	..	..	X	X	..	X			
grandis	..	..	..	..	..	..	..	..	X	X	X	X	X		
scabra	..	..	..	..	..	..	..	..	..	..	X	X	X		
amocana	..	..	..	..	..	..	..	..	..	..	X				
ligustrina	..	..	..	..	..	..	..	..	..	..	..	..	X		
speciosa	..	..	..	..	..	..	..	..	..	..	..	..	X		
burkillii	..	..	..	..	..	..	..	..	..	..	..	..	..	X	
glomerulata	..	..	..	..	..	..	..	..	..	..	..	..	..	X	
andamanica	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X

Key to the Series and Sub-series.

A. Stigma bifid ; shrubs, small or medium sized trees.

(*a*) Anthers borne on distinct and relatively long filaments and projecting beyond the corolla tube, linear or at least twice as long as broad (except *W. glomerulata*). Series I. **Euexsertae** (p. 353).

(*i*) Stipules pointed.

Sub-series 1. **Cuspidatae** (p. 353).

(*ii*) Stipules rounded and reflexed.

Sub-series 2. **Orbiculares** (p. 356).

(*b*) Anthers sessile or nearly so, ovoid or elliptical, and less than twice as long as broad (except *W. coriacea*, *W. heyneana*. *W. gamblei*).

Series II. **Subinclusae** (p. 359).

(*i*) Stipules pointed.

Sub-series 1. **Tinctoriae** (p. 359).

(*ii*) Stipules rounded and reflexed.

Sub-series 2. **Paniculatae** (p. 369).

B. Stigma clavate ; a straggly shrub.

Series III. **Clavigerae** (p. 372).

SERIES I.—EUEXSERTAE.

In this series the anthers are linear or linear-oblong with a cordate or sagittate base and are at least twice as long as broad (except in *W. glomerulata* Kurz, where they are ovoid and about as long as broad). They are moreover very definitely exserted being borne on relatively long distinct filaments at least as long as the anthers themselves. This series is divided into two sub-series, the Cuspidatae and the Orbiculares, according to whether the stipule is cuspidate and erect or rounded and reflexed. All the eight Indian species within this sub-series are very distinct and easily distinguished.

1. *SUB-SERIES CUSPIDATAE.*

Key to the species.

A. Calyx lobes longer than the receptacle, style with a few strigose hairs. 1. **W. ligustrina** (p. 354).

B. Calyx lobes shorter than the receptacle, style glabrous,

(*a*) Leaves sparsely or somewhat densely hairy below.

2. **W. puberula** (p. 354).

(*b*) Leaves glabrous below, or puberulous only on the main nerves. 3. **W. sikkimensis** (p. 355)

1. **Wendlandia ligustrina**. Wall. Cat. 6272, in part; Kurdz, For. Fl. Burma ii (1877), 74; Hook. f., Fl. Br. Ind. iii (1882), 39; Brandis, Ind. Trees (1906), 374; Cowan, Notes Roy. Bot. Gard. Edinburgh XVI (1932), 242.

Wendlandia nitens Hk. f., l.c., 38 in part; Brandis, l.c., 374 non Wall.

Burma: Shan Hills, 2—5,000 feet, at Maymyo, common and often in swampy forests, Taungyi, Fort Stedman. Distrib.: Yunnan.

Flowers during the rains, about the months of July to October and during the Burmese month of *Wazo,* hence the Burmese name *waso-ban.* The chief characters to be noted in this species are the much exserted anthers, the long corolla lobes, the calyx lobes longer than the receptacle, the style sparsely covered with long bristly hairs and the cuspidate stipules. Hooker in the Flora of British India describes the calyx lobes as shorter than the receptacle, whereas they are really longer.

2. **Wendlandia puberula** DC. Prod. IV (1830), 412; Hk. f., Fl. Br. Ind. iii (1882), 37, in part; Parker, For. Fl. Punjab (1924), 283; Osmaston, For. Fl. Kumaon (1927), 292; Kanjilal, For. Fl. (1928), 272; Cowan, l. c., 245.

Sub-Himalayan tract and Outer Himalaya ascending to 4,000 feet, from the Indus eastwards to Chamba, Kangra, Mussoorie, Malkot, Jaunsar and Tehri Garhwal, Kumaon, Nepal.

Fl. May—June; Fr. December—January.

Among the Indian species of the series Euexsertae, *W. puberula* DC. most resembles *W. wallichii* W. & A., *W. exserta* DC. and *W. appendiculata* Wall. in flower, but it has distinctly larger flowers than the first and from all three it differs in having cuspidate and not rounded, reflexed stipules. It has characteristic large, ovate-oblong leaves, acute at both ends, glabrescent above and hirsute-puberluous beneath.

The panicle is rather robust and dense, the receptacle and calyx lobes are somewhat pubescent, the anthers are long and far exserted and the stigma has two thickish lanceolate (not clavate) terminal lobes.

Hooker in the Flora of British India includes both *W. scabra* Kurz and *W. appendiculata* Wall. MSS. under *W. puberula* DC. *W. scabra* Kz., however, differs from *W. puberula* DC. in its flowers, with ovoid, almost sessile anthers and in having rounded, not pointed, stipules. *W. appendiculata* Wall. has the flowers of W. *puberula* DC. but differs from it in having oblanceolate or narrowly obovate leaves and orbicular stipules.

3. **Wendlandia sikkimensis** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 246.

Tree ; young branches greyish-brown, the older ones terete, slightly rough, reddish-brown. Leaves opposite, membranous, entire, elliptic or elliptic-oblong, glabrous on both sides, up to 15 cm. long, 5 cm. wide; apex acute or acuminate, base cuneate, midrib prominent beneath with 7—9 pairs of lateral nerves ; petiole channelled, 1—2·5 cm. long ; stipules persistent, distinctly cuspidate, more or less keeled. Inflorescence terminal, thinly pubescent, about 20 cm. long and much less across. Bracts linear or subulate, 2-6 mm. long. Flowers sessile frequently 3—fasciculate, the throat of the corolla tube white-hirsute towards the top, about 3 mm. long, lobes ovate about one-third or one-fourth the length of the tube ; calyx hardly 1 mm. long, distinctly pubescent, split about one-third into triangular lobes. Anthers linear or oblong about 1·5 mm. long, exserted, filaments about 1 mm. long, style lobes lanceolate, bifid.

Bengal and Sikkim : Darjeeling district, Sivoke Hills.

Fl. February.

A distinct species which, from superficial resemblances, has hitherto been confused with others. In its flowers it resembles the North-West Indian plant *W. puberula* DC. from which it may be distinguished by its glabrous elliptic or elliptic-oblong leaves, shorter filaments and longer calyx lobes. From the other Sikkim plants it may be distinguished as follows : from *W. wallichii* W. & A. by its

cuspidate, not rounded reflexed and early deciduous stipules and by the different texure and venation of the leaves: from *W. coriacea* DC. which has the receptacle glabrous, not pubescent, the stamens less exserted and the leaves more coriaceous and with more closely set veins: from *W. grandis* Cowan by its cuspidate stipules without a ligulate tip, narrower leaves and linear exserted anthers.

2. *SUB-SERIES ORBICULARES.*

Key to the species.

A. Panicle of short slender branches with flowers crowded near the tips. Anthers ovoid, about as long as broad.

4. **W. glomerulata** (p. 356).

B. Panicle robust spreading, flowers singly, or grouped, on the branches. Anthers linear, at least twice as long as broad.

(*a*) Leaves pubescent above, tomentose or greyish pubescent below. Corolla lobes longer than the tube.

5. **W. exserta** (p. 357).

(*b*) Leaves glabrous above, glabrous or with a few hairs on the nerves below. Corolla lobes shorter than the tube.

1. Receptacle glabrous, stipules early deciduous.

6. **W. wallichii** (p. 357).

2. Receptacle hairy or pubescent, stipules persistent.

(*i*) Leaves glabrous below. Style with a few strigose hairs.

7. **W. speciosa** (p. 358).

(*ii*) Leaves with a few hairs on the nerves below. Style glabrous.

8. **W. appendiculata** (p. 358).

4. **Wendlandia glomerulata** Kurz in Journ. Asiat. Soc. Bengal XLI (1872), 310, For. Fl. Burma ii (1877), 75; Hk. f., Fl. Br. Ind. iii (1882), 40; Brandis, Ind. Trees (1906) 374; Cowan, l. c., 249.

Burma: Tenasserim, on the banks of the Tenasserim River near Mergui.

Fl. February.

An interesting species unique in the genus in possessing much exserted stamens with, at the same time, small ovoid anthers. It

is easily recognised by its linear-lanceolate to lanceolate leaves, foliaceous reflexed stipules, sessile flowers in short stalked clusters (glomerules) forming a compact panicle, and by its long hispid calyx teeth.

5. **Wendlandia exserta** (Roxb.) DC. Prod. (1830), 411; Bedd., Fl. Sylv. S. India ii (1874), 130; Hk. f., Fl. Br. Ind. iii (1882), 37; Duthie, Flor. Upper Gangetic Plain i, pt. ii (1905), 418; Brandis, Ind. Trees (1906), 373; Haines, Fl. Chota Nagpur (1910), 498; Gamble, Fl. Madras pt. IV (1921), 587; Haines, Bot. Bihar and Orissa pt. IV (1922), 426; Parker, For. Fl. Punjab (1924), 283; Osmaston, For. Fl. Kumaon (1927), 292; Kanjilal, For. Fl. (1928), 271; Cowan, l. c., 249.

Rondeletia exserta Roxb. Hort. Beng. (1814), 14, Fl. Ind. i (1874), 523.

Dry forests of the Tropical Himalaya, from the Chenab eastward to Nepal and Sikkim ascending to 4,000 feet; hills of the Central Provinces, Bihar and Orissa and N. Circars; Western Ghats near Poona.

Fl. March—April.

The chief characters of this species are the short corolla tube, only slightly exceeded by the reflexed corolla lobes, the exserted stamens with linear anthers, the reflexed stipules and the tomentose under side of the leaves. The flowers are generally densely fascicled. Like several light-loving Rubiaceous plants it is frequently one of the first to appear on land slips and in abandoned *jhumed* areas where it may be often seen growing. It is therefore useful in afforestation work. It is also worth cultivating for its ornamental flowers.

6. **Wendlandia wallichii** Wight et Arnott Prod. i (1834), 402 in note; Hk. f., Fl. Br. Ind. iii (1882), 38; Brandis, Ind. Trees (1906), 373; Cowan, l. c., 252.

Sikkim Himalaya, alt. 2—4,000 feet; Khasia and Lushai Hills; Bhutan.

Fl. December—February.

From the North-West Indian species W. *puberula* DC., to which it shows obvious affinity, it may be distinguished by its smaller flowers,

which are intermediate in size between those of *W. puberula* and *W. exserta*, by its glabrous calyx, its corolla lobes shorter than the tube, V-shaped not U-shaped stigma, ovate reflexed stipules (as in *W. exserta*) which are early deciduous and frequently missing in herbarium specimens. The leaves are elliptic-lanceolate, 8-16 cm. long, 4-6 cm. wide, acuminate at both ends and minutely puberulous to almost glabrous on both surfaces.

6a. Var. **pedicellata** Cowan, l. c., 254.

A variety from Assam differing from the type by its more lax panicle, and for the most part shortly pedicellate flowers. The anthers are also slightly shorter and less exserted than in the typical *W. wallichii* W. & A.

7. **Wendlandia speciosa** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 254.

Tree or bushy shrub about 7-10m. high, young branchlets puberulous. Leaves opposite, coriaceous, broadly ovate, entire, 7-16 cm. long, 4·5-9 cm. wide, the apex more or less abruptly acute, narrowed at the base, glabrous or very sparsely pubescent above, glabrous beneath except along the nerves which are sparsely and shortly pale pubescent. Interpetiolar stipules 4 mm. long with leafy orbicular expansion at apex. Inflorescence terminal; panicle pubescent with linear bracteoles; flowers cream-coloured, fragrant, very shortly pedunculate, 9-10 cm. long; calyx with few greyish hairs, lobes lanceolate, acute, equalling the receptacle; corolla 5-fid, the tube pilose within, with ovate-rounded lobes one third as long; anthers exserted, lanceolate or linear-lanceolate, base bifid; style sparsely covered with hairs; stigma prominently bilobed.

Upper Burma : Kachin Hills. Distrib. : Yunnan.

This is one of the largest-flowered *Wendlandias.* It resembles *W. ligustrina* Wall. from which it is easily distinguished by its rounded reflexed stipules and larger ovate leaves. From the other species of the genus it can at once be separated by its sparsely hairy style.

8. **Wendlandia appendiculata** Wall. ex. Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 255.

Wendlandia puberula Hk. f. in Fl. Br. Ind. iii (1882), 38, in part, non DC.

Shrub or small tree, with thick furrowed branchlets the young parts brown pubescent. Leaves coriaceous, oblanceolate or narrowly-obovate, 11-16 cm. long, 3-6 cm. wide, apex shortly acuminate, base gradually narrowed, glabrous above, shortly and sparsely strigose beneath, with prominent midrib and nerves ; petiole 2 cm. long, stout; stipules orbicular, reflexing. Inflorescence 10-15 cm. long, the flowers sessile and glomerulate ; calyx cleft nearly half way with narrowly triangular lobes and with few long hirsute hairs. Corolla 4 mm. long, glabrous within ; stamens distinctly exserted with linear anthers. Stigma 2-lobed exserted.

Nepal : Makoll ?

Fl. April.

This species has the stipules of *W. paniculata* DC., the flowers of *W. puberula* DC. and in foliage most nearly resembles *W. coriacea* DC. In the Flora of British India it is included with *W. puberula* DC. but may be easily distinguished from that species by its orbicular reflexed and not cuspidate stipules and by its coriaceous, elliptic to oblong leaves. The stipules and the hairy (not glabrous) receptacle are characters which at once separate *W. appendiculata* Wall. from *W. coriacea* DC. and *W. gamblei* Cowan.

SERIES II.—SUBINCLUSAE.

In this series the anthers are sessile or nearly sessile and are borne on very short filaments, shorter than the anther itself, which arise between the corolla lobes. The shape of the anthers is usually elliptic to ovoid except in *W. coriacea* DC., *W. gamblei* Cowan and *W. heyneana* Wall., where they are oblong-linear. With these 3 exceptions the anthers are less than twice as long as broad. The stigma is bifid. The series is divided into two sub-series, the Tinctoriae and the Paniculatae.

1. *SUB-SERIES TINCTORIAE.*

This sub-series comprises a large complex group of inter-allied species with wide geographical range and, as would be expected, a certain similarity among the species making them difficult at times to

define. They differ chiefly in the relative size of their floral organs, the degree of pubescence, particularly in the calyx, and in the size, shape and texture of the leaves. The following notes draw attention to the main characteristics by which the various Indian species may be distinguished.

From all the other members of this group, two species, *W. angustifolia* W. & A. and *W. thyrsoidea* Steud. can be readily distinguished by their leaves being arranged normally in whorls of three.

W. coriacea DC. and *W. gamblei* Cowan are easily recognised by their oblong-linear anthers.

From *W. tinctoria* DC. with a tubular corolla, small ovoid anthers, a hairy receptacle and a cuspidate stipule the remaining species differ as follows :—

W. grandis Cowan, from Northern Bengal, has a much larger corolla tube, its stipules are furnished with a long flattened, pointed, ligulate tip and its leaves are larger and more broadly ovate than are those of *W. tinctoria* DC.

The sub-species *cinnamomea*, from South India, has a sparsely pubescent calyx and also differs from typical *W. tinctoria* in the texture of its leaf and by having hirsute stipules.

The sub-species *orientalis*, from Burma, is practically *W. tinctoria* DC. with a glabrous receptacle.

The following species with a glabrous receptacle differ from *W. tinctoria* in other characters also and have been kept distinct.

W. heyneana Wall., a South Indian species, has larger flowers than *W. tinctoria* DC. and minute rounded calyx lobes.

W. bicuspidata W. & A., from Ceylon, has flowers of about the same length as those of *W. tinctoria* but wider, and the leaves are characteristic. Its calyx lobes readily distinguish it from *W. heyneana* Wall.

W. amocana Cowan, from Chittagong, differs from *W. tinctoria* DC. in the distinctly infundibuliform or trumpet-shaped flowers, those of *W. tinctoria* being tubular ; the corolla is also rather short.

Key to the Species.

A. Leaves usually opposite. Calyx lobes not spathulate ; corolla tube at least twice the length of the corolla lobes.

I. Receptacle and calyx lobes hairy or pubescent.

(*i*) Stipule with a ligulate tip longer than the stipular base, calyx lobes as long as the receptacle.

9. **W. grandis** (p. 362).

(*ii*) Stipule cuspidate, the tip not longer than the base, calyx lobes shorter than the receptacle.

(*a*) Receptacle sparsely pubescent, stipules hirsute.

10. **W. tinctoria** sub-sp. **cinnamomea** (p. 363).

(*b*) Receptacle densely hairy.

11. **W. tinctoria** (p. 363).

II. Receptacle glabrous, calyx lobes glabrous or with a few hairs (No. 12).

*Corolla tubular.

(*a*) Corolla lobes strigose on the outside, the hairs forming a terminal tuft on the flower bud. Corolla tube 3·5 mm. long, leaves 6-8 nerved.

12. **W. tinctoria** sub-sp. **floribunda** (p. 364).

(*b*) Corolla lobes glabrous on the outside.

1. Panicle glabrous or glabrescent.

(*x*) Calyx lobes sharply triangular.

(*i*) Anthers elliptic or ovoid, not much longer than broad.

13. **W. tinctoria** sub-sp. **orientalis** (p. 364).

(*ii*) Anthers linear, more than twice as long as broad.

0. Upper half of petiole almost winged, by the long decurrent lamina.

14. **W. coriacea** (p. 364).

00. Upper half of petiole not winged, lamina shortly decurrent.

15. **W. gamblei** (p. 365).

(*y*) Calyx lobes rounded, minute.

16. **W. heyneana** (p. 365).

2. *Panicle* pubescent.

17. **W. bicuspidata** (p. 366).

** Corolla short and infundibular.

18. **W. amocana** (p. 367).

B. Leaves usually ternately whorled.

(*a*) Leaves linear-lanceolate, receptacle glabrous.

19. **W. angustifolia** (p. 368).

(*b*) Leaves ovate to elliptic lanceolate, receptacle pubescent or hairy. 20. **W. thyrsoidea** (p. 368).

9. **Wendlandia grandis** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 261.

Wendlandia tinctoria D.C. var. *grandis* Hk. f. in Fl. Br. Ind. iii (1882), 38.

Tree up to 14 m. high, the stem about 1 m. in girth; young branchlets pale brown, sulcate, glabrescent. Leaves coriaceous, smooth, ovate or ovate-elliptic, glabrous above with impressed midrib; more or less shortly hirsute only on the nerves beneath, 10-18 cm. long, 5-10 cm. wide abruptly shortly acuminate, base cuneate and narrowed to the glabrous 2-3 cm. long petiole. Interpetiolar stipules triangular, erect, the apex drawn out into a long point. Inflorescence pubescent, flowers sessile, fasciculate; corolla tube slender, about 5 mm. long, pilose towards the middle within, lobes ovate about one-eighth the length of the tube. Calyx densely pubescent, lobes obtuse triangular, almost equal to the receptacle. Anthers ovate, filments very short. Style bifid, slightly exserted.

Sikkim and Bhutan; Northern Bengal in the Darjeeling district and Jalpaiguri Duars; Eastern Bengal in the Chittagong Hill tracts; Assam, common, and Upper Burma.

Fl. February—April.

A species easily distinguished from *W. tinctoria* DC. by its longer flowers, much larger leaves, and stipules which, instead of having a short cuspidate point, have a long pointed appendage.

10. **Wendlandia tinctoria** (Roxb.) DC. Prod. IV (1830), 411; Kurz, For. Fl. Burma ii (1877), 74 in part; Duthie, Fl. Upper Gangetic Plain i, pt. ii (1905), 418; Brandis, Ind. Trees (1906), 374 in part; Haines, Fl. Chota Nagpur (1910), 499, Bot. Bihar and Orissa pt. IV (1922), 426; Cowan, l. c., 264.

Wendlandia tinctoria DC. var. *normalis* Hk. f. in Fl. Br. Ind. iii (1882), 38.

Rondeletia tinctoria Roxb. Hort. Bengal (1814), 15 and in Fl. Ind. i (1874), 522.

Sub-Himalayan tract from Oudh eastwards to Nepal, Sikkim up to 4,000 feet, Bhutan, Eastern Bengal, Assam, Khasia Hills and Burma. Also in Ganjam district. Distrib.: Siam.

Fl. January—March; Fr. March—April.

The type locality of this widely distributed plant is Burdwan and Midnapore in Bengal. It may be recognised by its oblong-lanceolate leaves, nearly glabrous above, sparingly hairy or glabrescent below, triangular stipules terminating in a cuspidate point, and small tubular flowers which are not hairy on the corolla. The receptacle and calyx lobes are more or less densely covered with long hairs, the lobes are about equal in length to the receptacle or somewhat shorter.

10a. Var. **callitricha** Cowan, l. c., 265.

A variety from Yunnan and Burma where it occurs in the Kachin Hills, S. Shan States, Pegu and Amherst districts. It differs from the true *W. tinctoria* DC. in the flowers which are more fasciculate than in the type and the hairs on the panicle and on the calyx being longer and denser, giving the inflorescence a somewhat more tomentose appearance. These variations are perhaps due to local conditions of soil and situation.

11. **Wendlandia tinctoria** DC. sub-sp. **cinnamomea** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 266.

A sub-species from the Kurnool district, in the Deccan, very closely allied to *W. tinctoria* DC. from which it may be distinguished by its pubescent calyx and brownish leaves, when dried. Included by Gamble in his Flora of Madras under *W. tinctoria* DC.

12. **Wendlandia tinctoria** DC. sub-sp. **floribunda** (Craib) Cowan in Craib, Flor. Siam. Enum. ii pt. i (1932), 23.

Wendlandia glabrata DC. var. *floribunda* Craib in Kew Bull. (1911), 386.

Wendlandia floribunda Craib in Kew Bull. (1913), 200.

Burma : Shan Hills. Distrib. ; Siam.

Fl. November—December.

Differs from the true *W. tinctoria* DC. by the few strigose hairs on the outside of the corolla lobes and the calyx glabrous or only very sparsely hairy. The panicle, even in the youngest parts, is practically without pubescence and the leaves are a little smaller. The corolla, however, is of the same shape and size and the anthers are similar in both.

13. **Wendlandia tinctoria** DC. sub-sp. **orientalis** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 268.

Wendlandia glabrata Hk. f., Fl. Br. Ind. iii (1882), 39 in part xvi DC. ; Kurz, For. Fl. Burma ii (1877), 74 in part xvi DC. ; Brandis, Ind. Trees (1906), 374 in part.

Assam : Lushai Hills, Manipur and Naga Hills up to 6,000 feet.

Burma : Ruby Mines, Arakan, Shan, Martaban and Tennaserim Yomas. Distrib. : Siam, Yunnan and Indo-China.

Fl. February.

A sub-species differing in flower from *W. tinctoria* DC. by its glabrous calyx—a character that can be fairly well relied on—and by its usually 6-nerved leaves.

14. **Wendlandia coriacea** DC. Prod. IV (1830), 412 ; Hk. f., Fl. Br. Ind. iii (1882), 39 ; Brandis, Ind. Trees (1906), 374 ; Cowan, l. C., 270.

Tropical Himalayas : Nepal, Sikkim and N. Bengal, 2,000—4,000 feet.

Fl. February—May.

This species, confined in its distribution chiefly to Nepal and Sikkim, has long, rather narrow, coriaceous, acuminate leaves. The

bracts on the panicle are remotely and irregularly serrate, the corolla tube is longer than that of *W. tinctoria* DC. and scarcely widens upwards. The anthers are linear to linear-oblong and are almost sessile, the stamens, although exserted, lie close to the corolla tube. The stipules are pointed.

15. **Wendlandia gamblei** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 271.

A small tree, glabrous in all its parts; young branchlets almost 4-angular more or less furrowed, reddish-brown. Leaves opposite or rarely 3-nate, elliptic or elliptic-oblong, glabrous on both sides, with prominent impressed midrib and 7-10 pairs of lateral nerves curved within the margin; apex shortly acuminate, base attenuate petiole 2-3 cm. long, the upper portion winged narrowly by the decurrent blade. Interpetiolar stipules with a narrow acute apex, soon deciduous. Inflorescence up to 18 cm. long and wide. Flowers sessile or subsessile 1-3 fasciculate furnished with single or paired inconspicuous bracteoles. Receptacle glabrous; calyx lobes small, acute or rounded, corolla tubular 8-9 mm. long, lobes ovate, reflexed, one-fourth the length of the tube, hairy within towards the middle. Anthers linear base sagittate, filaments very short. Stigma bifid, with thick lanceolate lobes. Capsule globose, crowned by the calyx lobes; seeds reticulate.

Madras : N. Circars, hills of the Ganjam, Vizagapatam and Godavari districts, up to 4,500 feet.

Fl. February—April.

Gamble, in the Flora of Madras, included this species under *W. glabrata* DC. a very different Javanese plant. It is not likely to be confused with the other Madras species (*W. heyneana* W. and A. and *W. bicuspidata* W. and A.) also with glabrous receptacle. It is clearly allied to the Nepal and Sikkim plant *W. coriacea* DC., which it closely resembles both in leaf and in flower, but the flowers are distinctly shorter.

16. **Wendlandia heyneana** Wall. Cat. 6,274; Wight et Arnott in Prod. i (1834), 403; Cowan l. c., 272.

Wendlandia glabrata Hk. f., Fl. Br. Ind. iii (1882), 39, in part xvi DC., Gamble Fl. Madras IV (1921), 586, in part xvi DC.

Madras : Hills of the Cudappah and Chingelput districts. Mysore?

Fl. March—April.

The type of this plant was collected by Dr. Heyne, probably in Mysore, and it was first described by Wight and Arnott in their Prodromus. In the Flora of British India it is included under *W. glabrata* DC. In the Flora of Madras it is also included, with the plant now called *W. gamblei* Cowan, under *W. glabrata* DC. so that the description there is a composite one covering three species. The two Madras plants are, however, quite distinct, *W. heyneana* having elliptic anthers, hairs in the throat of corolla, a more compact panicle with ascending branches and short petioled, more ovate leaves with a different texture and venation. *In W. heyneana* the corolla, 5-6 mm. long, is about five times as long as the ovate lobes themselves. The receptacle is glabrous and flatter than in the related species being as broad as, or broader than long. The younger parts of the panicle are very minutely pubescent. The leaves are 6-8 nerved, elliptic, somewhat abruptly cuneate at the base with a thick petiole 1-1·5 cm. in length. The stipules are small, triangular with a keel extending from the apex half way to the base and are ciliate on the margin.

17. **Wendlandia bicuspidata** Wight et Arnott in Prod. i (1834), 403 ; Gamble, Fl. Madras IV (1921), 587, 588 ; Cowan, l.c., 273.

Wendlandia notoniana Wall. var. *bicuspidata* Hk. f. in Fl. Br. Ind. iii (1882), 40.

Wendlandia notoniana Wall. var. *zeylanica* Hk. f. l. c., 40.

Ceylon.

This species is closely related to *W. heyneana* Wall. but the branchlets of *W. bicuspidata* W. and A. are ferrugineous-pubescent, the corolla is shorter, about 4 mm. long, and calyx lobes are distinctly triangular, not rounded, and very minute. In both species the receptacle is usually glabrous, it is rarely pubescent at the base in *W. bicuspidata* W. and A. The leaves of *W. bicuspidata* are opposite rarely ternate, obovate, acuminate, glabrous above, with short stiff

hairs at least on the nerves beneath. The stipules, sometimes bicuspidate, are commonly simply cuspidate, or they may be blunt or divided into two to the base. This variation in the shape of the stipule is certainly greater than is normally found within one species of the genus. In other species (*e.g., W. grandis* Cowan) both cuspidate and bicuspidate stipules may occasionally be found on the same shoot, particularly on young branches. Stress cannot, therefore, be laid upon this character which does not permit of the species being satisfactorily divided into varieties. From the data available at present this is the only species of *Wendlandia* found in Ceylon and it is apparently confined to that island. Gamble in the Flora of Madras gives it from the hills of Travancore but it appears never to have been definitely collected on the Peninsula.

18. **Wendlandia amocana** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 277.

Tree up to 12 m. high ; young branches, inflorescence and leaves glabrous, branchlets smooth, terete yellowish red. Leaves 8—15 cm. long by 4·5—5·5 cm. broad, membranous, elliptic-lanceolate, the apex long acuminate, the base narrowed, sometimes obliquely, to the short 1·5—2 cm. long petiole, midrib prominent, the 5—6 pairs of nerves strongly arcuate. Stipules widely triangular with cuspidate apex, about 3 mm. long, 2 mm. wide. Panicle about 20 cm. across. Flowers sessile, yellowish-white, gracefully arranged, 1-3-fasciculate, bracts subulate, hardly 2 mm. long, bracteoles minute hardly equalling the receptacle ; calyx-lobes triangular, acute, one-fourth or one-fifth as long as the glabrous receptacle ; corolla-tube 3 mm. long gradually dilated towards the mouth and furnished with hairs near the mouth within, lobes 5 shortly rounded ; style bifid, distinctly exserted, lobes obovate. Capsule about 1·5 mm. diameter, dehiscent almost to the base into two parts.

Bengal : District and Hill Tracts of Chittagong.

Fl. February—May.

This species differs markedly from *W. tinctoria* DC. sub-sp. *orientalis* Cowan in the shape and texture of its foliage and in its much

shorter flowers with a trumpet-shaped corolla and minute, ovoid, sessile anthers.

19. **Wendlandia angustifolia** Wight ex Hk. f. in Fl. Br. Ind. iii (1882), 40; Brandis, Ind. Trees (1906), 374; Gamble, Fl. Madras IV (1921), 588; Cowan, l. c., 279.

S. India: Tinnevelly, at Courtallam; beds of rivers and foot of ghats, rare.

The distinctive character of this species is its narrowly linear-lanceolate foliage.

20. **Wendlandia thyrsoidea** (Roth) Steud. Nom. Bot. ed. ii (1841) 786; Cowan, l. c., 280.

Webera thyrsoidea Roth, Nov. Pl. Spec. (1821), 149.

Wendlandia notoniana Wall. Cat (1828) 6,273; Wight, Icones Pl. Ind. Or. iii (1843—45), t. 1033; Bedd., Fl. Sylv. (1872), t. 224; Hk. f., Fl. Br. India iii (1882), 40 in part; Brandis, Ind. Trees (1906), 374; Fyson, Fl. Nilgiri and Pulney Hill-tops iii (1920), 355; Gamble, Fl. Madras IV (1921), 588.

Wendlandia lawii Hk. f. in Fl. Br. Ind. iii (1882), 40; Gamble, l. c., 588.

Western Ghats from Kanara to the Nilgiris, Pulney, Shevaroy and Anamallai hills and the Deccan plateau (Cudappah) from 3,000—6,000 feet.

Fl. February—July.

Following Gamble Hooker's variety *bicuspidata*, which differs in the size and shape of the flower and very obviously by having a glabrous receptacle, has been excluded from this species. The variety *zeylanica*, with flowers similar to those of *W. bicuspidata* W. and A., has also been excluded. *W. lawii* Hk. f. does not appear to be specifically distinct.

The usually ternate leaves and the folded, blunt and divergent, or even somewhat reflexed stipules and large pubescent panicle are the characters which best distinguish this South Indian species from its near allies,

20a. var. **lawii** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 282.

Wendlandia lawii Hk. f. in Fl. Br. Ind. iii (1882), 40 ; Gamble, Fl. Madras IV (1921), 588.

Bababudan Hills of Mysore.

This is merely a laxer form of *W. thyrsoidea* (Roth) Steud., differing only in the form of the panicle and by having shortly pedicelled flowers. It has only once been collected, by Mr. Law in the Bababudan Hills. The unusual development of the inflorescence may perhaps be due to some external agency ; the same sort of departure is found in other species, *e.g.*, *W. wallichii* W. and A. var. *pedicellata* Cowan.

2. *SUB-SERIES PANICULATÆ.*

The sub-series Paniculatæ is in many ways comparable to the sub-series Tinctoriæ in comprising again a complex of closely allied species. It includes all those species which have stamens with short filaments, elliptic anthers, and stipules with a rounded, more or less orbicular tip which is reflexed and often obscures the stipular stem. The flowers of some members of this group closely resemble those seen in the sub-series Tinctoriæ, but the two groups may easily be separated by examining the stipules, which in the Tinctoriæ are pointed. In foliage also there is, generally speaking, a further difference between the members of the two sub-series. Most of the Paniculatæ have leaves more or less strigose hairy on the under side, at least on the nerves, whereas the leaves of the Tinctoriæ have as a rule only a few shorter hairs or are perfectly glabrous.

Some interest is attached to the discovery of the type of *W. paniculata* DC. which has hitherto been considered an Indian plant but is now shown to be non-Indian. The type was brought by a Captain Anderson, from Amboyna in the Molucca Islands, about the latter end of the 18th century, to the Botanic Garden at Calcutta, where it flowered and was described by Roxburgh in his *Flora Indica* i (1832), 521 under the name *Rondeletia paniculata*. Later more than one allied Indian species were confused with it and it came to be described in the Flora of British India and in Indian Trees as an Indian plant.

Key to the species.

A. Calyx lobes about as long as or longer than the receptacle.
21. **W. scabra** (p. 370).

B. Calyx lobes half or less than half as long as the receptacle.

(*a*) Main branches of the panicle in the axils of leafy bracts.
22. **W. andamanica** (p. *370*).

(*b*) Main branches of the panicle without leafy bracts at the base.
23. **W. burkillii** (p. 371).

21. **Wendlandia scabra** Kurz in Journ. Asiatic Soc. Bengal XLI (1872), 310, For. Fl. Br. Burma ii (1877), 73 ; Cowan, l. c., 291.

Wendlandia puberula Hk. f., in Fl. Br. Ind. iii (1882), 38 in part non DC.

Wendlandia paniculata Hk. f., *l.* c., 39, in part, xiv *DC.* ; Brandis, Ind. Trees (1906), 374, in part.

East Bengal, Assam, Upper Burma. Distrib.: Siam, Yunnan. Fl. March—April.

The roughness of the upper surface of the leaf is a character by which this species can usually at once be distinguished.

22. **Wendlandia andamanica** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 295.

A small tree, the finer branchlets minutely puberulous, at length glabrous. Leaves 11-18 cm. long by 4-7 cm. broad, elliptic or elliptic-ovate, narrowed at both ends, the apex usually abruptly acuminate or sub-acuminate, sometimes turned to the side, perfectly glabrous at maturity, base cuneate. Petiole 1—2 cm. long, moderately thick, somewhat winged towards the leaf blade. Stipules orbicular, reflexed. Inflorescence terminal more or less equalling the leaves, the spreading branches minutely brown pubescent. Lower bracts lanceolate, sometimes petiolate, the upper one linear. Flowers 1—2 rarely 3-fasciculate, bracteoles spathulate sometimes spurred ; receptacle ovoid, slightly pubescent, calyx lobes almost glabrous, triangular acute, hardly equalling the receptacle ; corolla tube nearly cylindric,

4 mm. long, white hirsute at the throat, the lobes obtuse and reflexed about one-third the length of the tube. Anthers ovoid twice as long as the filaments. Stigma exserted, bifid the lobes narrowly obovate. Capsule globose ; seeds very minute sometimes obscurely winged.

Andaman Islands : Mount Harriett, Port Blair.

Fl. March—May.

This species is probably confined to the Andamans and easily distinguished from its nearest allies by its glabrous or almost glabrous, elliptic, to elliptic-ovate, tapering leaves, relatively long calyx lobes and glabrous orbicular reflexed stipules. It can be readily separated from *W. wallichii* W. and A., with which it has been confused, by its longer corolla tube, short ovoid and much less exserted anthers.

23. **Wendlandia burkillii** Cowan in Notes Roy. Bot. Gard. Edin. XVI (1932), 297.

A small tree or shrub, 5-7 m. high, young branchlets 4-angular deeply grooved. Leaves membranous, ovate or broadly so, up to 14 cm. long by 8·5 cm. broad, apex abruptly acute or shortly acuminate glabrous on both surfaces or sparsely setulose beneath, nerves 8—11 pairs distinctly impressed, arched ; petiole slender, channelled, about 1·5 cm. long, stipules shortly stalked, apex rounded and reflexed. Inflorescence ample, branchlets and flowers hardly crowded, up to 15 cm. long by 20 cm. across ; bracts linear-lanceolate ; bracteoles ovate, pubescent, hardly equalling the receptacle. Calyx split about one-third into 5 more or less obtuse rounded lobes, longish grey pubescent ; corolla inverted bell-shaped at the base, the throat white-hirsute, tube 4 mm. long, lobes one-third or a fourth as long. Anthers oblong, almost sessile. Style much exserted, the apex divided into two widely triangular lobes.

Lower Burma : Martaban hills of the Thaton district and Dawna hills.

Fl. February—May.

From the Burmese plant *W. scabra* Kurz this species may be separated by the texture and shape of the leaves which are glabrous above, by its less dense panicle and shortly pubescent calyx teeth.

SERIES III. CLAVIGERÆ.

There is only one species belonging to this series, and when in flower it may be readily recognised by its clavate stigma. In habit it is an elegant but somewhat straggly shrub with slender branches.

24. **Wendlandia pendula** (Roxb.) DC. Prod. IV (1830), 412; Hk. f., Fl. Br. Ind. iii (1882), 41; Brandis, Ind. Trees (1906), 374; Cowan, l. c., 302.

Rondeletia pendula Roxb. Fl. Indica ii (1824), 140.

Hills of Nepal, Bhutan, Assam and Manipur from 2,000—6,000 feet. *Distrib.* Yunnan.

A very distinct species with pendulous branches, lanceolate ovate leaves, usually in threes, and with a sparingly branched panicle. The style is very far exserted, up to nearly twice as long as the corolla tube. The clavate stigma is a distinctive character.

Explanation of Plates.

(All figures x 8).

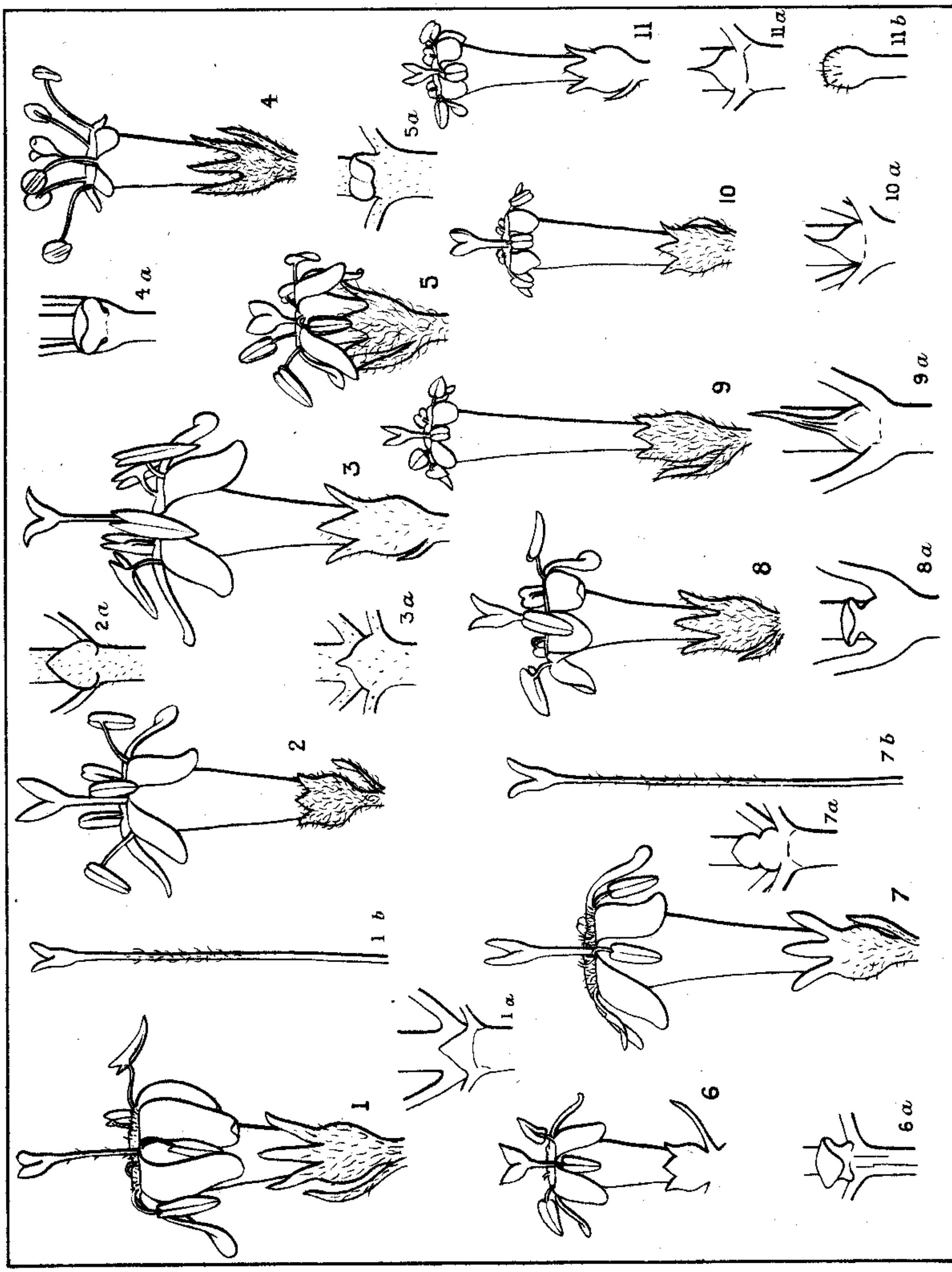
Plate XIX.—Fig. 1. W. ligustrina. Fig. 2. W. puberula. Fig. 3. W. sikkimensis. Fig. 4. W. glomerulata. Fig. 5. W. exserta. Fig. 6. W. wallichii. Fig. 7. W. speciosa. Fig. 8. W. appendiculata. Fig. 9. W. grandis. Fig. 10. W. tinctoria. Fig. 11. W. floribunda.

Plate XX.—*Fig. 12 W. orientalis. Fig. 13. W. coriacea. Fig. 14.* W. gamblei. Fig. 15. W. heyneana. Fig. 16. W. bicuspidata. Fig. 17. W. amocana. Fig. 18. W. angustifolia. Fig. 19. W. thyrsoidea. Fig. 20. W. scabra. Fig. 21. W. andamanica. Fig. 22. W. burkillii. Fig. 23. W. pendula.

EUROPEAN SILVICULTURAL RESEARCH, PART VII :—THINNING INVESTIGATIONS AND PRUNING.

By H. G. Champion, I.F.S.

Special attention was given to research methods for thinning problems, as the subject is one which involves a number of special difficulties both in execution and interpretation. Thinning investigations almost invariably require to be carried out in fully demarcated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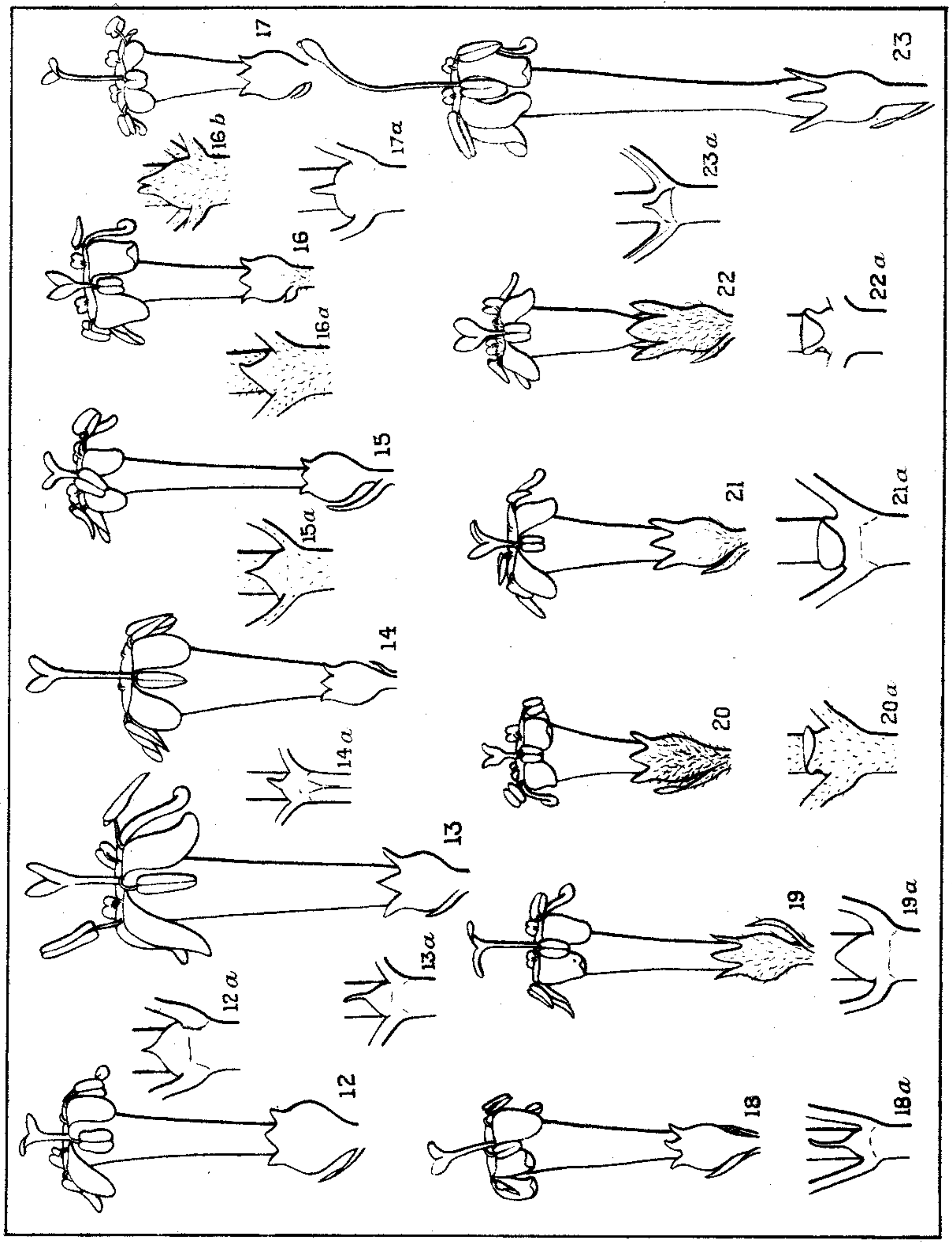
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sample plots maintained over a long period of years. The studies are also always comparative and so call for pairs or series of plots of adequate size, and these are difficult to find. Initial comparability is essential, and must be demonstrated objectively to remain convincing to later observers, and uniformity of maintenance is equally important. These points will be discussed more fully later on, and a general survey of present day tendencies and lines of thought will form the best introduction to the subject.

The first tendency to be noted is the still spreading one to shorter thinning cycles, naturally with a lightening in intensity each time, but on the whole resulting in a higher aggregate intensity from the point of view of the relation between the volumes removed in thinnings and remaining as main crop or realised as final crop. A 5 year cycle is quite usual during the period of rapid growth and three or even two years by no means exceptional, and this although it is very general for the Divisional Forest Officer to do the greater part of the marking personally. A suggestion met with which perhaps reveals the common attitude for conifers is that, as a very rough approximation, the thinning cycle in years should equal the number of decades of age.

Then one is struck by the increasing popularity of crown thinnings, particularly in those regions such as Switzerland where the reaction against even-aged forest, or at least short regeneration periods, is most pronounced. Apart from special conditions, the tendency is to concentrate attention early on the stems of the future, the *élite,* and thin systematically in their favour, just as advocated by Heck in his *Freie Durchforstung.* This method is certainly gaining in favour and being more widely adopted even if there is still plenty of room for difference of opinion as to the statistical evidence in its support.

The natural extension of this idea and one which is of considerable significance to India, above all for *sal* forests, is to determine how far one can go in this direction of favouring selected stems before the loss in total increment and in technical quality of timber through increased branchiness, balances the financial gain resulting from the price increment with concentration of as much as possible of the total volume increment in a minimum number of stems of proportionately

larger diameter. This line has been followed up in many centres, particularly in Hannover by Dr. Gehrhardt who has introduced the term *Schnellwuchsbetrieb*, literally 'management for rapid growth' to describe the thinning treatment required to give this maximum growth with highest financial return.

The importance of initial comparability has not been overlooked on the continent, but the usual practical difficulties of finding suitable plots have generally driven investigators to the alternative of countering the differences which unavoidably occur between the individuals of a pair or set of plots by replicating the experiments in the hope of randomising the plot differences with reference to treatment differences. As far as could be ascertained, there is no Latin square of thinning plots on the continent, and the British Forestry Commission has the distinction of having laid out the first such set in a young spruce plantation at Bowmont Castle, in the private forests of the Duke of Roxburgh. This experiment deals with four grades of thinning, three grades of ordinary thinning and one of crown thinning, the plots being each 0.1 acre. A detailed analysis of the crop initially on the 16 plots demonstrated acceptable comparability in height, basal area and volume; comparison of the four plots of one treatment after the initial thinning revealed rather more variation but still within acceptable limits. With a view to maximum elimination of personal factors in carrying out the thinnings, removals are based as strictly as possible on the Commission's standardised tree classification and thinning scale.

On the continent, Dr. Busse has however one interesting set of replicated plots with the ABCABCABC lay out, in a spruce plantation near Tharandt, to investigate the relative merits of 1, 5 and 10 years' thinning cycles. His method is to do the very light annual thinning with special regard to the best-growing stems, and to thin the other plots in the prescribed years to the same basal area as that then standing in the one year plots. The experiment is too recent to give results yet.

The Sachsenried set of thinning plots in Bavaria was one of the best seen. Two closely adjoining sets of plots were laid out in 1883 in spruce then 33 years old, one set being in a planted area and the

other from sowings. The plots have been thinned approximately five yearly under A, B and C grades of ordinary thinning. A complete duplication was laid out in 1902 close by in a rather younger crop, *thus giving 4 repetitions in all. The plots have an adequate surround* and a ten metre separation strip between members of a set. Here too, the actual thinnings are done as far as possible on the tree classification, but laterly the removals have been checked against the approximate percentage relationship between the number of stems for the several grades, ratios of 2 : $1\frac{1}{2}$: 1 to $1\frac{3}{4}$: $1\frac{1}{4}$: 1 being taken as suitable for A : B : C. The results of the last measurement, kindly communicated by one of the staff, shew for the total basal area production of the 1883 crops A : B : C=115 : 123 : 117, sowings and plantings agreeing very closely, whilst the standing basal areas are 70 : 64 : 53 square metres. The younger replication gives a rather different result, with C-grade the most productive by a small margin. These sets of plots are as good as one can hope for, and they serve admirably to demonstrate the need of many repetitions before safe generalisation becomes possible.

For Austria, Dr. H. Schmied has been studying the subject and has recently published (*Mitt. Forstl. Mariabrunn*, 1931) results of one very interesting study on increment fellings in beech, the basic plots of which were seen with him. The following extract gives the essentials of the summarised results from this set of plots initiated in 1888 :—

" The lightest increment felling (to 0·8 by basal area of the heavily thinned control plot) resulted in the maximum total volume production in stem timber and total volumes, with 7, 8 and 10 per cent. more respectively than the control.

The heaviest felling (to 0·5 of the control) shewed a slightly smaller stem volume than the control, timber and total volume being intermediate between the control and the medium felling.

The money equivalent of the total volume production is greater for the opened out crops than for the heavily thinned control, the *medium felling (to 0·65 by basal area) shewing the greatest money* yield and the heaviest felling showing a small falling off. The ratio

of the actual values are roughly 15·8, 17·5, 18·5 and 18·2 for successively heavier felling."

The figures for the average diameter of the biggest 100 stems are also of interest, being 40·9, 42·8, 46·0 and 50·1 cms. respectively, so that a gain of 22 per cent. has resulted with the heaviest felling.

Many of the older plots dealt mainly with what are now considered unduly light thinnings, but have been adapted during the last decade to cover the wider range up to a definite increment felling. There are now some 18 sets of comparative plots to provide against unrealised initial differences, the crops appearing on the whole very uniform.

Dr. Gehrhardt's studies are of special interest to us in India as they deal primarily with the question of concentrating the potential increment of a tree crop into the minimum number of stems consistent with avoiding bad stem form and consequent low value per unit of volume; in other words, with the question of getting the biggest possible average diameter with a given rotation, without loss in money return from reduced total volume or poor quality timber.

The problem was discussed with Dr. Gehrhardt in some of his beech and spruce plots near Münden in Hannover, and the following notes recorded. The plots mostly lack controls which is ascribed to insufficient staff and time: the surrounding crops have accordingly to be accepted as the control with the assumption that existing yield tables apply to them. This is of course a rather big matter from the point of research technique and is only partly met by having a considerable number of plots. None of the special plots are as yet much over 30 years old, so that the deduction from them can only serve as indicating possibilities for the whole life of tree crops. Forecasts for greater ages are based on extrapolations, deductions for crop data from selected single tree data, and so on, all matters which involve big personal factors and on which opinion is bound to differ. The actual thinning is based on a separately determined specific optimum crown length; thus for spruce, it is taken from observation of the best growing single trees that the crown should be about two-fifths of the total height, and never less than one-third. Once again, the method is that

of the crown thinning, and the *élite* stems are pruned at each thinning to a total height of 30 to 45 feet although it is asserted that this is not essential, but merely extra expenditure which will be amply recouped later on. It is agreed that the method is inapplicable in crops below second quality. A summary of the information available in Prussia on this question of the results and value of heavy thinnings and the *Schnellwuchsbetrieb*, has recently been published by Dr. Wiedemann with whom also the subject was discussed (*Ztsch. f. F. u. J. Wesen*, 1929, p. 701).

To recapitulate, there is a considerable body of opinion that on good soils, it is possible to concentrate volume increment on selected stems and so get the benefit of the usually prevailing price increment with increasing diameter without incurring counterbalancing disadvantages. There is on the other hand a pronounced undercurrent of doubt as to whether the claims made for the extent of the gain are not exaggerated and whether it is not too early yet to arrive at any generalisations on the subject (loc. cit. 1930, p. 795). The need of data covering a longer period is unquestionable, but most research centres have taken up the investigation and the next few decades should give a much clearer answer.

Experiments on the subject of initial spacing in plantations were referred to in the last article of this series in connection with the fine sets of experimental plots at Wermsdorf, Markersbach and Reudnitz in Saxony, at Kocherhof in Baden, and Mariabrunn in Austria, and the conclusion reached that a limit is very quickly reached beyond which economies in plants and planting costs are more than offset by a falling off in the value of the timber grown.

The optimum age at which thinning should begin is often in question, and a set of plots was visited in Mariabrunn (Ex. 228) which was laid out in 1894 in beech regeneration of 1879 to study this point. The method followed was to remove the same percentage of the existing basal area at ages 15, 18, 21 and 24, continuing the thinning on a 3-year cycle changed later to a 5-year one. A detailed account of the experiment, which was replicated with topping instead of ordinary fellings, has been published by Dr. Schmied (*Cb. f. d. ges. Forstwesen*, 1930) the

main conclusion being that delayed thinning resulted in a small permanent loss in height, but the loss in diameter was subsequently made up.

Pruning.—It has been mentioned above that Dr. Gehrhardt believes in the benefit of pruning the selected stems of the future with his *Schnellwuchsbetrieb* and one or two other examples of the adoption of pruning in forestry were met with. In a general way, however, it is a rare practice. In England, comprehensive experiments have been started in the Forest of Dean with several species, to determine the nature and extent of the effect of pruning on the cleanness and value of the timber produced. The production of graded clean timber comparable with that imported from abroad is one of the chief forest problems in England, and it is quite possible that the rather high costs may be more than recouped when it comes to marketing the timber. Variations in the proportion of the pruned length to the total height of the bole are under trial with Latin square layout.

The lessons to be drawn for Indian forestry from the present attitude in Europe with regard to thinnings may be summarised as follows :—

Thinning investigations require much replication of plots as comparability is very difficult to obtain and the variation in the quantities under study are mostly small relative to the experimental errors. The end results to be of real value must be expressed in monetary units, so that the record of material produced must be adequately classified into assortments and a suitable average price for each assortment determined. Every species has its own characteristics and it is not permissible to generalise from results with one species to another; similarly for varying localities. To carry any weight, thinning experiments must cover a long period of time and it becomes important to lay out acceptable series of plots at the earliest possible date.

As for so many species in India there is a very sudden and great price increment when trees reach certain marketable dimensions, and often almost no sale at all for trees of smaller diameter, so the extent

to which diameter increment can be raised by suitable thinning treatment is a matter of the first importance. For species to which it is suited, crown thinning promises to be most helpful in this way, minimising the exposure of the soil and the felling of unsaleable material, and we ought to lay out plots to study it wherever we have suitable crops and no prospective demand for small material. On good soils, the evidence is to the effect that very heavy ordinary thinning may give considerably enhanced diameter increment without appreciable loss of total production and without serious deterioration of stem form : this requires early statistical study for most of our chief species. On poor soils, however, thinning requires to be done with great caution, or soil deterioration may result and the response of the crop be feeble or negative. In plantations in areas with keen demand for clean timber, pruning of selected stems of the future, at each thinning, will probably repay the costs.

RECENT ADVANCES IN PASTURE MANAGEMENT.

BY O. MCCONKEY, PUBLISHED AT ONE SHILLING BY H. M. STATIONERY OFFICE, LONDON.

Readers who were interested in our editorial of March 1933 on the better utilisation of forests for grazing and who wish to have a simple and readable summary of the grazing problem would do well to obtain this excellent pamphlet which deals with it on broad lines, chiefly to show how the recent research work in the intensive methods of smaller European countries can be applied to the extensive areas of India and the colonies. The author emphasises the need of studying the effect of the animal upon the pasture as well as that of the

pasture upon the animal, and produces convincing statistics to show the benefits gained from a scientifically controlled rotation of grazing which can produce grazing crops of the best possible food value and digestibility. The following quotation is a good example :—

" At Aberystwyth, Wales, three lots of lambs were rotated over three ranges, each of which was sub-divided into five paddocks. The grazing was arranged so that on one range the lambs were moved from plot to plot every week, thus giving each plot an interval of four weeks' rest—this is referred to as the " month " strip ; the next as the " fortnight " strip, and lastly the " four-day " strip where the lambs were moved from plot to plot every day so that each plot had only four days' rest between consecutive grazing.

From the following data it is seen that the most frequent grazing resulted not only in a lower increase in live weight, but also in a lower carrying capacity.

Resting period of sward.		*Gain in lb. live weight per acre.*		*Lamb days per acre.*	
		1928	1929	1928	1929
Month	..	183	175	1,557	1,865
Fortnight	..	166	167	1,355	1,700
Four days	..	133	132	1,225	1,695

This is a most interesting and valuable experiment in that it shows the value of rotational grazing which can now be recognized as a fundamental principle to be followed in successful pasture management. The reason being that from the physiological-botanical standpoint grass which is grazed too closely in the " four-day " strip is robbed of its vitality and is therefore not able to develop a good root system or leafy surface for maximum photosynthetic action, whereas the plants in the " month " strip have a chance to develop a good root system and a large leaf surface and the plants on a given area are able to manufacture much more food material than on a comparative area

of the "four-day" strip. The food nutrients are better balanced in the older grass provided it is not allowed to become lignified. The animals satisfy their appetite quickly where there is plenty of grass on the "month" strip and lie down in contentment, a most important factor in profitable animal production."

"The value of rotational grazing is still further substantiated by the convincing work of Dr. H. E. Woodman, Cambridge, by the experiment in which plots of pasture were cut by a lawn mower at weekly, fortnightly and three-weekly cuttings, giving the following yields :—

Period 13th April to beginning of October.		*Dry matter per acre, lb., 1928.*
Weekly cutting	..	1,982
Fortnightly cutting	..	2,562
Three-weekly cutting	..	3,216

Dr. Woodman says "though the herbage obtained under the more lenient three-weekly system of cutting was somewhat less rich in digestible protein, it was nevertheless equal in respect of digestibility and nutritive value to grass grown under systems of weekly and fortnightly cutting. At the end of three weeks' unchecked growth, pasture grass still consists of non-lignified, highly-digestible tissue as at the end of a week's or of a fortnight's growth. It was further demonstrated that the depressing influence of drought on the protein content and digestibility of pasture grass is much less marked under a system of three-weekly cutting than under the severer system of cutting every week."

R. M. G.

EXTRACTS.

TIMBER AS AN ENGINEERING MATERIAL.

Timber as an engineering material comprised the subject for the first meeting of the year, on November 17, of the New York district members of the American Society for Testing Materials. The program arranged by Hermann von Schrenk, consulting engineer, St. Louis, and chairman of the society's committee on timber, was planned to present the view points of both user and manufacturer. J. V. Neubert, chief engineer, maintenance of way, New York Central Lines, and president, American Railway Engineering Association, and E. J. Russell, St. Louis, president, American Institute of Architects, represented the user side of the question. J. F. Carter, chief engineer, Southern Pine Association, outlined the progressive steps that have been taken by the lumber associations to place lumber in the class of engineering materials. Mr. von

Schrenk reviewed the progress made in protecting timber against deterioration. A motion picture film prepared by the British Wood Preservers' Association portrayed some remarkable microphotography of fungus growth and insect action in destroying timber.

Long-life creosoted timber.—Railroads are probably the largest users of timber as a result of their huge cross-tie requirements, said Mr. Neubert, who reviewed the growth of the use of preservative treatment from its very meagre beginning about 25 years ago. At that time it was estimated that creosote treatment would increase the life of a cross tie to 16 years from an 8 to 10-year life, which was common for untreated ties. Experience on the New York Central Lines has shown that the life of a treated tie is nearer 25 years than the estimated 16. According to Mr. Neubert no composite or substitute tie yet developed can offer the economy and long life that has been proved for treated timber ties.

Greater uniformity needed.—Lack of uniformity and the poor quality of much lumber were given by Mr. Russell as the principal reasons why it was not used in greater volume by the building industry. While these reasons do not apply as widely today as formerly, thanks to the activities of the lumber manufacturers, the architect in general is not yet aware of this fact. Grade-marking and improved manufacture have done much to place timber in the class of engineering materials, but in Mr. Russell's opinion the lumber industry must treat all of its products so as to protect it from deterioration and fire before the building industry will accept it without reservation.

That the lumberman is making it easier for engineers to specify timber with certainty as to its quality and uniformity was emphasized by Mr. Carter who also urged engineers to give the same serious consideration to the qualities and characteristics of timber and lumber that they do to other construction materials. Engineers should not attempt to write their own specifications for lumber, as many of them do, but should place absolute reliance on the specification drawn up by the lumber associations. Briefly, lumber manufacturers suggest the use of their grade-use recommendations and in addition that engineers insist that every piece of lumber shall bear the official grade mark of the lumber manufacturer. By these means all worries about the haziness of grade rules will be eliminated. Present-day timber, said Mr. Carter, is selected, manufactured and graded in accordance with principles laid down by the engineering fraternity, and if those engineering principles are sound, it is logical that designers and specifiers should use the lumber association's values in designs. The heavy factors of safety which have been so frequently employed not only hurt the lumber industry but add to the cost of the structure and should be discarded.

Lumber industry facilitates design.—Some of the progressive activities of the lumber industry are as follows :—designing connectors for post, beam, truss and arch members ; producing glued-up members from smaller pieces ; treating at lower cost to resist decay, insect and flame ; fabricating at the mills to exact size and shape for construction in both large and small structures, drying to more uniform moisture content, improving paintability ; designing ready-made panels. One other activity that has

been proposed, and will be adopted by the Southern Pine Association, at least, is the establishment of a department to inspect and grade mark treated material.

In discussing preservative treatment for timber, Mr. von Schrenk stated that impregnation is the only efficient method. Painting of preservatives is a waste of money. The impregnation chemicals must not only be initially poisonous to fungi, termites, etc., but must remain poisonous over a period of years. Preserved timber, in the opinion of Mr. von Schrenk, can be made to last just as long as the economic life of the structure into which it is placed. On the Big Four Railroad the life of creosoted timber is 26·6 years while ties placed in 1910, 22 years ago, are still in good condition. Creosoted bridge timbers have an even longer life because they usually are not subjected to mechanical destruction as are cross ties. Creosoted piles have an indefinitely long life, and are being widely adopted as evidence by the fact that 17 million were installed in 1930 as against 4 million in 1909. Mr. von Schrenk pointed out the danger of using untreated wood for river and harbour structures and counting upon the pollution of water by sewage to keep marine organisms out. The increasing demand for sewage treatment may result in the cleaning up of these waters with the result that marine organisms will destroy the untreated timber structures. Creosoted timber bridge decks should be so designed that long horizontal flues are not formed by the stringers. If anything, American practice does not use enough creosote per piece of timber. European practice could teach us something in this regard, said Mr. von Schrenk.

Engineering News-Record, 24th *Novr.* 1932).

THE CULTIVATION OF *FARASH* (*TAMARIX ARTICULATA* VAHL).

[*Paper presented by P. N. Suri and R. S. Chopra at the Punjab Forest Conference held at Lahore in February* 1933.]

Introduction.—Farash, the Oriental tamarisk, is a moderate sized tree of the Punjab plains, Sindh and Baluchistan. Beyond India it is found in Afghanistan, Persia, Arabia and even in North and Central Africa. It commonly grows in the Punjab plains, chiefly from Delhi westwards, in the saline tracts in association with *van* (*Salvadora oleoides*, Dcne.), *jand* (*Prosopis spicigera*, Linn.), and *karir* (*Capparis aphylla*, Roth). At one time these dry *rakhs* occupied extensive areas in the Punjab, forming the chief source of fuel supply in the plains, but with the spread of irrigation they are fast disappearing. In the early days the astounding success with *shisham* planting in the irrigated plantations, followed by an invasion of mulberry made afforestation a comparatively simple problem. However, it was not long before it was realised that *shisham* would not grow everywhere, not at any rate, in very light or very stiff soils, or in those impregnated with alkali (*kallar* soils). The first serious difficulty was experienced in Khanewal plantation in Multan district, where in 1923, a few years after the start of *shisham* planting, it was noticed that the resulting crop over extensive areas exhibited appreciably stunted growth in patches alternating with normal growth. Cutting back was tried over 1,588 acres, but gave no satisfactory results. The cut back stems coppiced vigorously, but refused to grow beyond the

sapling stage. The failure was attributed to shallow soil, to sand layers in the subsoil or to an inadequate water supply (all of which explanations are believed now to be incorrect). Eventually the area was stock mapped and in 1928 *shisham* planting was abandoned over 1,839 acres with the intention of restocking with *farash*, the species indigenous to such areas.

In the wake of the Khanewal trouble there arose another serious problem—that of the shortage of water supply in the new plantations on the Sutlej Valley Project. The supply here is inadequate and irregular throughout the season except for the flood months. Sometimes when the river is running low no water is available before the middle or end of June resulting in a serious set-back to the *shisham* crop. Taking into consideration the requirements of this species, the normal supply made available is calculated to be hardly sufficient for stocking with *shisham* 50—60 per cent. of the area of the individual plantations. This is how *farash* has come into prominence during the past few years. Very little was known about its cultivation prior to 1928. In that year, a beginning was made in Khanewal plantation with the planting of *farash* shoot cuttings over an area of 48 acres. Since then the planting of cuttings has been extended to other plantations as well, and about 3,000 acres have been stocked by this method in Khanewal alone. Efforts to raise the species from seed were initiated in 1931 and continued in 1932. A volume of useful and interesting information on its propagation both by seed and cuttings has been collected and is detailed below.

I.—PROPAGATION BY SEED.

In nature, *farash* is seen coming up gregariously in saline soils, depressions and low-lying areas where water collects, or along canal banks and water-courses and the beds of ancient rivers. The tiny seed with a hairy pappus is blown to such places and there finds sufficient moisture for its germination. Once the root system is developed, the plant only grows enough to resist drought and the inclemencies of the hot weather.

Seeding.—The seed is minute and downy with a tuft of soft, woolly, white hair. It is enclosed in a brownish capsule, each capsule containing 4—6 seeds. Ripe, partly opened capsules weigh 13,650 to the ounce. The seed ripens in the middle of July and continues doing so till the 1st-2nd week of November. The flowers are uni-or bisexual, white to pink, scattered on long slender spikes collected in loose panicles at the end of the branches. The flower buds first appear in the beginning of June, open out towards the end of the month and after pollination the capsules begin to form and the seed to ripen in the middle of July. Ripe capsules turn brown, gradually open up and the seed is blown away. Flowering, fruiting and seeding go on simultaneously till about the middle of October. Seed is available till the middle of November, but by then appears to be of little value for propagation.

Collection.—Very young *farash* trees have been seen to seed, but it is only the mature trees which produce prolific seed every year especially those growing along canal banks. The seed should preferably be collected from such trees. Blotting paper and flannel tests have shown that ripe seed in quantity can only be collected from the beginning of August to the end of September. In the month of September

much seed is blown away, leaving very little on the trees. The fertility of the seed diminishes from October onwards and the seed then on the trees has been observed to be smaller in size than that found in August-September. Closed capsules do not contain any fertile seed. It is only *capsules which are just opening or have partly opened and from which the seed is about to be blown away, that should be collected*. Much of the failure in past work has been due to the collection of the wrong type of seed. Owing to the minuteness of the seed great care is necessary in its collection. The best way is to shake the twigs laden with ripe capsules into tins or canvas bags and place them on wire trays through which the seed falls.

Storage.—Blotting paper and flannel tests were carried out with seed stored in thin paper bags and in tins, the period of storage varying from 2 days to over a month. It was observed that the seed collected during August-September would ordinarily stand storage for 2—3 days, although in one or two cases seed stored for over a week gave some germination. It was observed, however, that each day of storage diminished the germinating capacity of the seed and success could only be ensured with immediate sowing. The black ant has been found to be destructive, collecting and removing seed both when stored and sown.

Sowing Methods.—As for seed-treatment, it has been experienced that given right type of seed, *i.e.*, seed collected from ripe, partly opened capsules, and sown soon after collection, pretreatment is entirely unnecessary. The seed is minute and all that is necessary is to take care that it is not blown away at the time of sowing. For this purpose the following devices have been found efficient—

(*i*) mixing the seed with silt or sand before sowing ;

(*ii*) moistening the seed a little before sowing ;

(*iii*) flooding the beds and sowing the seed when the water has almost soaked in, so that the seed settles down along with the water, *i.e.*, sowing on wet beds ;

(*iv*) sowing on moist beds and lightly watering with a fine rose so that the seed sticks to the beds.

Any of these methods will do for nursery practice, but Nos. (*ii*) and (*iii*) are best suited for forest sowings.

As regards the soil media, sound seed will germinate in any media but it will not thrive in very light, stiff or rich soils. Canal silt and saline loam have been found most suitable. Nursery experiments in pure *white kallar* soil have failed, but some success is reported from Montgomery Division in *black kallar*.

As for sowing methods, ordinary pots watered from the top have proved an utter failure. The germinating seedlings are too tender ; with top watering they are either covered with mud and die or they get uprooted and fade away. In nursery practice, sowing in bottomless pots or in wet or moist flooded beds has been found most successful. In forest work, sowing on the wet berms of trenches or on sloping patches along the berm of trenches appears suitable ; the latter method has been successfully tried in Montgomery Division.

Germination.—The germination period varies with the time of sowing and to some extent with the nature of the soil. From July to September the seed germinates

within a day or two at the most. Later in the season, it takes 3—5 days or even more to germinate, perhaps on account of the low temperature and the reduced vitality of the seed. Stiff soils retard germination. In the actual process of germination, the seed swells up and turns green within 12—24 hours of sowing, it then bursts open and in a day or so two minute cotyledons appear. The cotyledonary stage ordinarily persists for 8—10 days, when the first leaves appear. In pots kept in the shade this period is prolonged for as much as 3 weeks. Gradually within the next two weeks whorls of leaves appear and the plants begin to show up. Side branches are discernible in about 5 weeks when the seedlings have reached a height of over an inch. To start with, the cotyledons are of light green colour, turning dark green or brown on the appearance of secondary leaves. Later the leaves become thick and fleshy, and the plant assumes a purplish green colour.

Watering and tending.—For seed germination and the establishment of the seedling, continuous moisture and an undisturbed bed are essential factors. It is, therefore, necessary that the beds, trenches or pots, as the case may be, should be thoroughly watered prior to sowing. This preliminary watering usually suffices for germination. Later on, watering by percolation is by far the best. If beds are to be hand-watered it should be done with a fine rose, pouring a little water at a time and repeating the operation when it has soaked down, until the beds become sufficiently moist. If the beds are flooded or water allowed to stand in the beds, the tiny seedlings are uprooted or covered with silt and thus wither away or damp off. This care is necessary only for the first 5 weeks or so by which time the rudimentary branches begin to show and the plant is firmly established. Once this stage is reached, the water requirements of the seedling become low and watering seems to be immaterial. During the first month, nursery beds may be watered on alternate days or as required ; later once to twice a week will do. When the seedlings have attained a height of 3″—4″ they can go without water for a very long time. Nursery beds sown in Lahore on 8th September 1932 have only been given about 3 waterings during November, since when water has been discontinued and the plants are flourishing. This fact is confirmed by experiments carried out in Montgomery Division and in the Silvicultural Research Garden at Chichawatni. *Black kallar* soil is more retentive of moisture and so needs less frequent waterings than average soil. The seedlings do not suffer from frost. Some mortality resulted from suppression by grass in trench sowing in Montgomery Division but further observations and experiments are needed to come to a definite conclusion as to the necessity and intensity of weeding.

Side shade against the hot sun conserves moisture and helps in development of seedlings. Sowing early in the season is decidedly advantageous.

Summary.—(*i*) *Collection of the right type of seed is the key to success.*—Ripe seed should be collected during August-September from *partly opened* capsules. Mature trees, especially those growing along water-courses, or in low-lying area give good seed. The seed does not stand storage.

(*ii*) August and September are the best months for sowing, the earlier the better. *Fresh* seed should be sown on a wet surface whether in pots, shallow beds or on the berm of trenches.

(*iii*) Continued moisture is necessary for the establishment of seedlings till the secondary branches appear in about a month. Submergence in water kills the seedlings.

(*iv*) Water requirement of the established seedling is quite low. It can stand drought and frost.

(*v*) Early development of seedlings is very slow, average 3—4 inches in 4 months.

(*vi*) The species does best in saline loam. Very light and stiff soils are unsuitable.

II.—PRAPOGATION BY CUTTINGS.

Planting of shoot cuttings is extensively used at present for propagation of the species in the plantations and elsewhere. Large areas have been stocked with *farash* by this method, particularly in Khanewal plantation where M. Mushtaq Ahmad has developed a regular planting technique described below. Stump transplants (root and shoot cuttings) are more expensive and nothing appears to be gained by their use.

Preparation and size of cuttings.—Farash cuttings are simply branches of healthy green *farash* cut to a length of about 15″ and of the thickness of the thumb. Cuttings taken from trees growing along water-courses do best. Cuttings from purple coloured branches are hard to sprout while those from green branches do better. The ends are cut oblique and care is taken that the bark is not split. In passing cuttings prepared by the coolies, the crooked and dried ones are rejected. Good straight cuttings are accepted and tied in bundles of 100 each with their thick ends pointing one way. This end is given a dip in a coloured solution to distinguish it later. They are packed in wet bags for transport and kept in the shade until planted.

Nursery experiments were carried out in Khanewal and Miranpur plantations in the winter of 1931 with cuttings of various diameters and lengths, thick cuttings about ½″ in diameter gave the best results; the length made no difference so long as it exceeded 6″ below ground. Further experiments were tried this year in the Silvicultural Research Garden at Chichawatni to determine the best size for cuttings. Cuttings varying in length from 6″—12″, and in mid-diameter from under ¼″ to 1″ were planted in nursery beds in August-September. Cuttings 12″ long (planted 3″ above and 9″ below ground) with mid-diameter of ¼″—½″ gave the best results, 68 per cent. sprouting, 41 per cent. survivals. Thinner cuttings sprouted poorly. Cuttings planted flush with the ground resulted in complete failure due probably to the buds being buried.

Method and season of planting.—Cuttings are planted with as little delay as possible after preparation. The area taken up for planting is cleared and trenched beforehand and is watered the previous evening in order to moisten the berms to make them soft enough for a cutting to be pushed in. The cuttings are carried to site and put in baskets. A cooly takes up a basket and goes on pushing in a cutting every 2 feet, about 3″ from the edge of the trench roughly parallel to it, with coloured end downward and slightly out of the vertical, leaving 3″ above ground. Care is necessary to see that the trenches are not filled to overflowing, otherwise there is a tendency to plant the cuttings too far from the berm which is bad.

The correct planting season has been a controversial matter for some time; it has been stated that cuttings planted in April—May take longer to sprout and result in much mortality due to the intense heat, and that August planting after the rains gives a better percentage of sprouting. This late planting has many disadvantages:—

(*i*) It reduces the planting period and large areas cannot be tackled in a short time.

(*ii*) The water received cannot be utilised elsewhere during the period planting is not taken in hand, and consequently there is no saving on water rates.

(*iii*) The plants get the benefit of a short growing season only, and are less able to withstand the ensuing hot weather.

(*iv*) Failures have to be replaced the next year, whereas, in the case of early planting this can be done the same year.

(*v*) Plants are less fitted to withstand weed growth than those resulting from early planting and the weeding cost is comparatively high. In consideration of the above facts early planting has ultimately been found to be the best and more economical method.

Espacement.—*Farash* has the habit of spreading and soon closing up, so a spacing of 12′ × 8′ to 12′ × 12′ or 15′ × 8′ is considered most suitable. In actual practice, however, closer planting 2 feet apart is done as the mortality is very high (75 per cent.). Cuttings are planted spaced 2′ in trenches 15′ apart. This ordinarily ensures a living plant at the requisite distance with one planting and saves water, labour and money on subsequent replacements. The percentage of striking and growth is very low in soils which do not contain plenty of salts, black *kallar* soil being best.

Watering and water requirements.—Cuttings sprout in 7 to 23 days of planting, depending on the soil, the season of planting and the condition of cuttings at the time of planting. All the energies of the plant in the beginning are directed towards the development of its root system. Roots spring up from different points in the embedded portion of the cutting and expand laterally. The most vigorous lateral root near the bottom takes up the function of a tap root and penetrates deep into the soil. The shoot development in one season averages to about 2½—3 feet, the maximum being 10 feet. After planting, cuttings require a continuous supply of moisture for establishment and growth during the 1st year when the root system is still in a rudimentary stage. Submergence in water is harmful as the silt kills the young shoots. Water requirements and the interval between various waterings depend upon the nature of the soil. *Kallar* soils are more retentive of moisture and require less water and at longer intervals. Watering should be done every 8 to 14 days, with shorter intervals immediately after planting and during May-June in the first year.

Experiments are in progress in Khanewal plantation to determine the optimum depth of water required by the species on various soils at different stages in its life in order to produce the maximum volume in the shortest time. No conclusive results can, however, be drawn until the experiments have gone through a full rotation. At present a delta of 3—4 feet delivered in 8—12 irrigations is being given in Multan

Division and this is considered to be somewhere near the optimum. In good *kallar* soils, even a 2 feet depth has been found to give satisfactory results.

Tending.—*Farash* cannot stand any weeds and they must not be allowed to overgrow it. *Dab* (*Eragrostis cynosuroides,* Beauv) and *gharm* (*Panicum antidotale,* Retz) grasses are particularly injurious, they do not give the plants a chance to make any headway. Areas with heavy weed growth may require 3—4 weedings in one year. Cultivation under the *taungya* system by raising cotton along with *farash* on the other side of the trench is suggested by some officers to meet the weeding and planting cost, but its success is doubtful as *farash* will not tolerate any shade.

Damage by white-ants is a heavy source of mortality and a practical remedy is yet to be found. Cuttings soaked in solutions of borax, alum, or nicotine were also attacked by white-ants though to a less degree.

Cost.—The average cost of various operations in Multan Division is as follows :—

	Rs. a. p.	Rs. a. p.
1. Preparation of 1,500 cuttings per acre planted at $2\frac{1}{2}' \times 12'$ @ Re. 1-2-0 per ‰ ..	1 11 0	
2. Carriage to site of 1,500 cuttings @ Re. 0-1-6 per ‰ ..	0 2 3	2 12 3
3. Planting of 1,500 cuttings @ Re. 0-10-0 per ‰ ..	0 15 0	
4. Weeding (*i*) bad areas per acre Rs. 1-8-0 to 2-4-0		
(*ii*) Ordinary areas per acre. Re. 0-6-0 to 0-8-0		
5. Cutting coppice in old *shisham* areas per acre Re. 0-8-0		

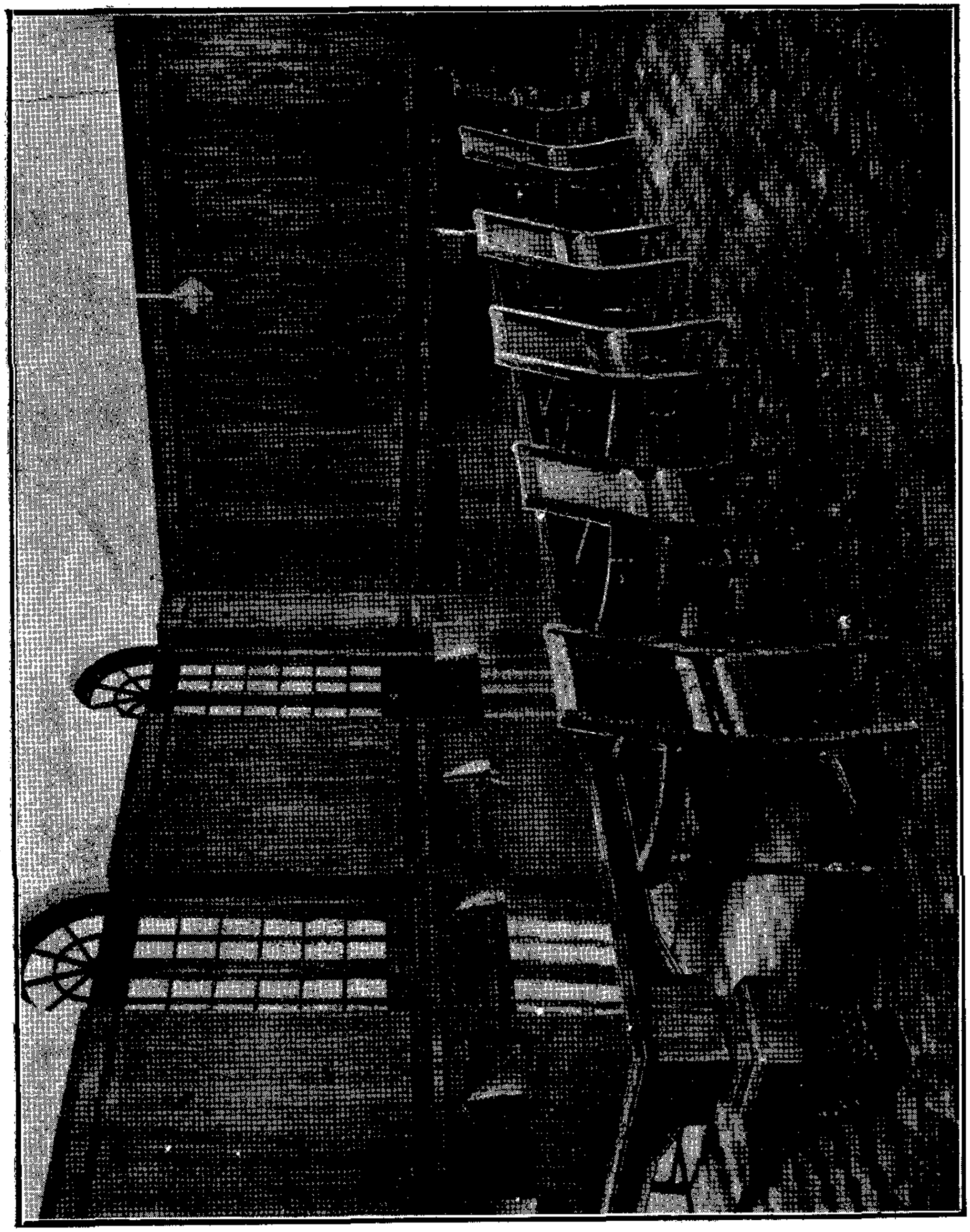
The average cost of stocking per acre, of new and abandoned areas, exclusive of trenching and watering, works out as under—

		Rs. a. p.
(*i*) New areas with average weed growth	..	3 3 0
(*ii*) New areas with heavy weed growth	..	4 10 0
(*iii*) Abandoned areas with average weed growth	..	3 11 0
(*iv*) Abandoned areas with heavy weed growth	..	5 2 0

Conclusion.—This much is, at any rate, manifest that *farash* is the species for certain soils and as such, it has a place of its own in the Punjab 'irrigated plantations.' Its late sowing season and drought resisting capacity offer a solution to the problem of low, late and uncertain supplies of water, with which we are faced in the plantations on the Sutlej Valley Project. Some consider it as a useless tree and are doubtful of its market value. True, it cannot compare with *shisham* or mulberry, yet the consumer in the plains needs no introduction to the species. He is familiar with its economic value as cheap fire-wood, for turnery and agricultural implements, and is prepared to pay a fair price for it. The clearance of millions of cubic feet of *farash* firewood from *rakhs* disforested for colonization should afford enough guarantee in this respect.

RECENT NUMBERS OF INDIAN FORESTER WANTED

The entire stock of the *Indian Forester* for January, February and March, 1933, has been sold out, and in order to meet the occasional demands for back numbers we wish to secure a small reserve of these issues. We also require a copy of each of the *Indian Forester* issues for June, 1920, April, 1925, January, 1927 and May-July, 1927. Would readers who are willing to sell their copies back to us at Re. 1 per copy, kindly send a postcard to the Editor saying so.



Board Room in the Forest Research Institute, New Forest, Dehra Dun.
Photo: Har Swarup, March 1933.

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A REVOLUTION IN PANELLING.

BY

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Most, if not all of us, are acquainted with the old type of solid panelling with its aptitude for warping, splitting, shrinking and expanding at the whim of variable climatic conditions together with the dust-carrying faculties of the bolection and other types of mouldings which are provided with rebates to hold the panels in position and to hide shrinkage and expansion discrepancies.

To-day, thanks to the introduction of laminated boards, the system of panelling has been more or less revolutionized, making it safe to display the thinnest of handsome veneers taken from rare and priceless logs, thereby conserving valuable figured material and consuming in the main timber of lesser value for cores and crossbands. A further feature in the use of laminated board as a core is that it lends itself admirably to the possibility of creating veneer designs not feasible with solid wood. By judicious selection and quartering of veneers there is no limit to the balanced designs which can be obtained to cover large laminated cores, the stability of which makes this possible.

There are several forms of laminated boards for which it is claimed they will not swell, shrink or split, but in the main, when considering laminated boards for panelling, the methods employed are either the gluing together of heavy veneers or of building the cores up with small section timber in mural design. In the former case, which appears to be the most popular, heavy rotary cut veneers are obtained by means of a Rotary Lathe, the principle being to rotate the log against a knife of the length of the log or longer which automatically travels forward

towards the log as the log is being reduced in diameter, thereby producing continuous sheets of veneer from the rear of the machine. These sheets are next clipped to a pre-determined size after which they are relieved of their moisture by one of the several present day types of mechanical drier.

Having been brought down to a suitable moisture content the sheets are next glued or cemented together into the form of blocks when they are next converted into sections ranging from about ½″ to 2″ according to requirements. These sheets or sections form the core which after being dried receives sheets of moderately heavy veneer or crossbands on both faces, the veneers being cemented to the core with their grains at right angles to those of the core.

It will thus be seen that the assembly takes the form of a " bond " which if properly constructed and balanced will retain its shape with freedom from such defects as are common to solid wood. In other words the peculiar form of assembly used in manufacturing laminated boards makes them as near to homogeneous in the matter of balance and strength distribution as it is possible to make timber, and since waterproof cement is usually used in the construction the joints are more or less impervious to the action of moisture.

Our illustration depicts a modern design in flush panelling in the Board Room at the Forest Research Institute, Dehra Dun. The face veneers are of matched figured *Terminalia tomentosa* (laurel) cemented to cores made respectively with *Dalbergia sissoo* (*sissoo*), *Cedrela toona* (*toon*), *Pinus longifolia* (*chir*), *Cupressus torulosa* (cypress), *Duabanga sonneratioides* (*lampatti*), *Cerdus deodara* (deodar) and *Abies pindrow* (Himalayan silver fir). The veneers used for crossbands are of *Dalbergia sissoo* (*sissoo*), *Cedrela toona* (*toon*) and *Calophyllum tomentosum* (*poon*).

The cores of these panels were built up with small section timber of the species described above, the bulk of the stuff being taken from short ends and other workshop and mill residue. After assembly the cores were brought to an 8 per cent. moisture content, after which the crossband veneers were cemented to them to form laminated

boards. These boards were then re-dried to extract the foreign moisture introduced by the cement and finally the valuable face veneers of matched patterns were applied, a balancing veneer of inferior quality being cemented to the backs of the boards to prevent " pull."

The finished panels were joined edge to edge and the whole fixed to the walls as one huge panel, thereby eliminating the use of framing and giving a flush effect.

The adhesive used throughout was a waterproof casein cement the ingredients of which are ground casein and definite percentages of the following salts:—sodium fluoride, sodium silicate, calcium hydroxide, copper sulphate.

The parquet flooring is of herring-bone design in *Carapa moluccensis* (*pussur*). The blocks were laid direct to a cement floor, " Floatine " being used as the adhesive. It may be of interest to some readers to know that we obtained the best adhesion results, wood to cement, by first washing the cement base with kerosene oil before applying the hot Floatine.

The table, a magnificent piece of furniture, is of Andaman *padauk* (*Pterocarpus dalbergioides*) and is 7 feet wide and 24½ feet in length. It was built by Chinese carpènters and has extensile joints, which permit the top to expand and contract without cracking, a very necessary precaution even with fully seasoned wood for such a large surface. The chairs are also of *padauk*.

CALCULATION OF YIELD FOR *SAL* FORESTS.

By

E. A. Smythies, I. F. S.

1. In my first article on *sal* regeneration, published in the *Indian Forester*, April 1932, I endeavoured to show that *sal* natural regeneration depends more on the correct stage of an ecological progression rather than on any skill of man, and cannot therefore be guaranteed when and where we wish. In my second article of January 1933, I showed how the recognition of this phenomenon is forcing us off the

"conversion-to-uniform" standard, and the systems or methods of management that we have to adopt instead. In this third and final article, I hope to show how this and some other factors compel us to reconsider our methods of calculating and prescribing the yield of our *sal* forests, and to indicate the methods of yield calculation, which we are now tending to adopt in the current working plan revisions in the United Provinces.

2. Before doing so however, it seems advisable to define clearly what we are primarily aiming at in our working plans and yield prescriptions, as there seems to have been some confusion of thought of recent years on this point. In Indian forests, often situated far from the consuming markets and with relatively poor communications, the size of tree which can be exploited at all is usually very high compared to European standards and it is indisputable for the bulk of *sal* forests in the United Provinces that it is the selection tree (*i.e.*, the large tree above the *minimum* exploitable diameter or girth), which brings in the revenue. While European forestry often aims at sustained *total* yield, it is more usually a matter of paramount importance in Indian forestry to aim at guaranteeing the sustained yield of the *selection* tree. The full implication of this difference between European and Indian forestry has not, I think, always been realised in Indian working plans.

3. There has been a tendency in some working plans to regard *everything* over the selection limit as surplus stock and to legislate for its removal in a comparatively short period. This, I venture to think, is a mistake, which partly explains the decreasing yield and revenue from selection trees, which is a feature of some of our *sal* working plans. As the selection class is our main source of revenue, we ought rather to try and decide what is a reasonable or normal stock and yield for this class, and then endeavour to the best of our ability to sustain it. Otherwise I fail to see how we can maintain our revenue. I will assume then that our first object of management is a sustained *selection* yield, and in this article I will first endeavour to show by concrete examples how and why our management has often failed to safeguard the selection yield, and secondly, since destructive criticism by itself

is useless, to describe the method of yield calculation and control which, I believe, ensures a sustained selection yield, either with selection fellings or clear fellings.

4. Although the shelterwood system applied to *sal* seedling regeneration is being gradually given up for the present in parts of the United Provinces, and the method of yield calculation as hitherto applied to this system will be seldom adopted in future, it will be instructive to examine how and why it has failed before letting it pass into oblivion, or at least until we can guarantee quick results. (To avoid misunderstanding, I should explain that we are *not* giving up conversion-to-uniform entirely, but rather we are adopting or expanding it *wherever sal regeneration is required which we can guarantee immediately*).

In the first place the primary object of management was *not* a sustained selection yield, but it was to produce as quickly as possible a normal distribution of the age classes in evenaged groups or blocks, and frequently a sustained selection yield was ignored or sacrificed to attain this object. This resulted in overfelling of the selection trees in areas outside P. B. I. and the sacrifice of immature trees in P. B. I.

Secondly, the volume yield calculation for P. B. I. was based on the assumption that the whole enumerated growing stock (plus increment) would be removed in a fixed period, an assumption that *must* be a fallacy if it is admitted that natural *sal* regeneration is frequently if not normally an ecological progression which suffers no time limit, and which is amenable to no ordinary standards of European silviculture.

Thirdly, it was impossible at first even to visualise how extremely expensive in the long run natural seedling regeneration under a shelterwood was liable to be. Under the most favourable conditions anything in the nature of an ecological progression must be a slow business, and wherever we have as an initial step somehow to produce or reproduce the right stage of the progression before natural regeneration can even begin, the period may extend indefinitely. In a heavily opened regeneration area, the loss of increment over

incalculable years adds a tremendous cost, while any artificial stimuli we may apply to hurry up the process (such as deer fences, controlled burning, shrub cutting, weeding, etc.) will help to swell the cost.

And so let us for the present write a temporary epitaph of the shelterwood system for natural *sal* seedling regeneration, until the above points are satisfactorily solved.

5. To turn now to the method of selection fellings and thinnings as defined in my second article. In several of the U. P. *sal* divisions the number and yield of selection trees has dropped appreciably in the last 20 years (although the total growing stock has increased considerably, proving that we have not been felling the full increment), and it will be instructive to take the successive working plans for one of these divisions and see how the selection yield has not been safeguarded.

The first important working plan was prepared in 1895 for the period 1896—1914 (18 years). The method of selection fellings by area was adopted, with a rigid limitation of number of selection trees (over 6′ girth) that might be marked. Complete enumerations in 18″ girth classes showed the number of selection trees (X) and the number in the next lower girth class, *i.e.*, 4′-6″—6′ (Y, which as it happened was equal to $3\frac{1}{4}$ X). The limitation on the removal of selection trees was calculated with great caution. It was estimated that in two felling cycles of 18 years each, *i.e.*, in 36 years, all the Y trees less 25 per cent. would pass up to X and as Y was $3\frac{1}{4}$ X, the prescribed limitation for the first felling cycle, *i.e.*, $\frac{1}{2}$ X plus $\frac{1}{8}$ Y, guaranteed a considerable increase in X in subsequent felling cycles. The future supply of selection trees was therefore amply safeguarded, in fact the *yield was unnecessarily conservative.*

6. The next working plan was prepared in 1914-15 for the period 1915—1936 and divided the forest into a Selection working circle and a Conversion-to-uniform working circle. In the former, the selection limit was reduced to 5′ girth, because it was held that this approximated to the physical rotation as deterioration and rot were very prevalent above the previous limit of 6′ girth. The working circle was divided

into 20 annual coupes, and every tree in the year's coupe over 5′ girth could be taken out if silviculturally available. The working plan realised and pointed out very clearly that if everysuch tree was taken, there would be a considerable drop in the next felling cycle, but hoped there would be sufficient trees not *silviculturally available* to prevent this. In other words the numerical safeguard of the selection yield was dropped, and experience has shown that the silvicultural safeguard even when combined with a definite warning is not always adequate.

An alteration of divisional boundaries in 1921 made it necessary to modify the 1916 working plan, and a five-year scheme for 1921—26 was prepared and substituted. This scheme undoubtedly accelerated the overfelling of the selection trees and the yield and revenue of the division during its currency shot up rapidly.

In the Selection working circle, while the selection limit was kept at 5′ girth, the felling cycle was reduced to 15 years, and every encouragement was given to remove *all* selection trees in this shorter period. The Divisional Forest Officer was given no warning that this *must* lead to a very considerable drop in revenue in the next felling cycle.

7. In the 1924—34 working plan, the division of the whole forest into a Selection working circle and a Conversion-to-uniform working circle was continued. In the Selection working circle the selection limit was vaguely defined as 18—20″ diameter, and all mature trees over these diameters could be removed on a 15 year cycle if not required for silvicultural reasons. The safeguarding of the selection yield was not even considered as an object of management. Thus there was no adequate safeguard of the selection yield and credit for the survival of the existing selection crop—depleted though it is—is due rather to *cautious* Divisional Forest Officers than to the working plans.

8. I have picked at random one U. P. *sal* division and examined working plans serially over a period of 40 years; each working plan was more or less typical of its period and the series gives us convincing evidence of our original cautious treatment 30 and 40 years ago, and of our systematic neglect during the last 15 or 20 years of the principle of sustained selection yield. It is scarcely surprising that the

selection yield has dropped in several *sal* divisions. It is due to the innate conservatism of the average forest officer that the drop is not so serious as it might have been and further, it is due to the wonderful response made by our *sal* forests to protection from fire and grazing which started 60 years ago, that we can say the drop is only temporary, and in a few more decades the rise in the selection yield again seems inevitable, if we are reasonably cautious in the interval.

9. Having examined some examples of area yields failing to safeguard the selection trees, let us examine some examples of volume yield calculated for a whole working circle.

The best example in the United Provinces is North Kheri working circle I of the 1923—33 working plan. Here complete enumerations of the growing stock were made down to 8″ diameter and a volume yield in volume units prescribed, calculated on the Burma formula (a modification of Von Mantel) :—

$$Y = \frac{V}{\frac{1}{2}R\left(1 - \frac{X^2}{R^2}\right)},$$

where V=total growing stock over 8″ diameter.
R=Rotation.
X=Age of 8″ trees.

In this working circle it must be noted, that 78 per cent. of the trees enumerated and 47 per cent. of the total growing stock in volume units were included in the 8″—12″ and 12″—16″ diameter classes, while only 9·5 per cent. of the trees enumerated were in the 20″ and over (selection) class. As I pointed out in my article in the *Indian Forester* of January 1933, the young middle-aged crops were in excess, their presence swelled the volume yield, an undue proportion of which was removed from over 20″ class, thereby tending to remove these too rapidly. Thus while the *total* growing stock was safeguarded by the formula adopted, the sustained supply of selection trees was not, and in North Kheri it is most emphatically the selection trees which produce the revenue. This is an excellent example of the importance in Indian forestry of safeguarding the selection tree rather than of safeguarding total volume of growing stock,

It is, so far as I can see, impossible to justify calculating a volume yield for a forest where the distribution of the diameter classes is abnormal and then removing the whole or an excessive proportion of that yield in selection trees only.

10. The same formula is used in Burma teak working plans for calculating the yield of selection trees in a Selection working circle (*e.g.*, para. 137 of the Mu working plan of 1929-30). A volume yield in basal area is calculated on the total growing stock down to 8″ diameter, but the actual yield is apparently only removed (or very largely removed) in trees 28″ in diameter and over. But having calculated a volume yield in this way, the Burma plans do not necessarily adopt it. They apply a check practically on the lines suggested later in this note, *i.e.*, they calculate the annual yield in trees from the number that pass up from the next lower diameter class, to which something is added for removal of *surplus* selection trees spread over a long period, and thus obtain another figure of yield. This figure appears usually to be lower than the formula yield, and the *prescribed* yield is somewhere between the two.

As indicated in para. 9 of this note, for the average irregular forest in India it is difficult to justify a volume yield (calculated on the whole growing stock), being removed only in the selection class, and the additional check applied in Burma depends for its accuracy on the assumed felling cycle not being shortened in actual practice. The Burma plans therefore put yet another check on the fellings and " the progress of the felling is reviewed annually by the Conservator of Forests, Working Plans Circle, who indicates the steps which should be taken to reduce any excess or make up any deficit." Such steps include raising or lowering the selection girth.

Thus although the Burma plans nominally use a volume yield, they also adopt adequate safeguards for the selection tree, and the scope of these safeguards suggests that they have not very much faith in the volume yield by itself. One is left rather in doubt what useful purpose the calculation of the volume yield actually serves, and whether it is really necessary.

11. In Bengal, another formula is used for calculating a volume yield for the whole forest, the yield being derived partly from clear-fellings, partly from dry fellings, and partly from selection fellings. This formula is as follows :—

$$Y = \frac{G}{R} + \frac{G}{2} \times \frac{i}{100}$$

where G = the enumerated growing stock over 12″ diameter (trees below this size being markedly absent)

$\frac{i}{100}$ = the annual increment per cent. and

R = rotation or conversion period=80 years.

The underlying idea of this formula is that there will be no recruitment of the present growing stock from trees below 12″ diameter (since all regeneration stopped 30 or 40 years ago), that the whole forest will be covered with a new crop (by *taungya*) in 80 years, and hence the present growing stock plus its increment may be felled in that time.

Here difficulty was experienced with the calculation of increment, $\left(\frac{G}{2} \times \frac{i}{100} \right)$, which is calculated from the *sal* yield table in cubic feet, while markings against the prescribed volume yield are in volume units, and this part of the yield, which is primarily earmarked for dry timber and selection fellings outside P. B. I. is too low. This, as it happens, safeguards the selection trees outside P. B. I. fairly well, as the dry timber markings (plus a bad wind break) have so far absorbed this part of the yield to a great extent. But if this part of the yield was correctly calculated, it would be necessary to calculate and allot some percentage of it to thinnings in order to safeguard selection trees outside P. B. I.

Incidentally the working plan permits any balance from the first part of the formula $\left(\frac{G}{R}\right)$ to be removed in selection fellings outside P. B. I., provided the correct area of P. B. I., *i.e.*, $\frac{1}{80}$ of the working circle, is felled for regeneration, and although it would average out in the end, this would enable a cunning Divisional Forest Officer to get the bulk of his yield from dry and selection fellings for a few years by judiciously choosing parts of P. B. I. with little or no *sal*.

This will suffice to show that this formula for calculating the volume yield does not automatically safeguard the selection tree. It also illustrates the difficulties of a volume yield that involves a calculation of increment being applied to Indian conditions. But the underlying idea is extremely good and seems a good solution to apply to any *sal* forest where the *sal* is naturally disappearing. In Bengal the *sal* is dying out due to excessive moisture, in the U. P. there are *sal* tracts where the *sal* is dying out due to excessive dessication.

12. Considering volume yields generally, so far as I can see, under the usual conditions of our irregular *sal* forests, where smaller diameter trees are of little value and possibly even unsaleable, a volume yield based on increment and or growing stock of the whole forest cannot by itself safeguard the sustained yield of selection trees. For in a normal and fully stocked *sal* forest, as each 4″ diameter class passes into the next higher diameter class, from 30 to 40 per cent. of the trees disappear, *and are included in the total volume yield.* I have never seen in any working plan that a fixed per cent. of the total volume yield *must* be taken out in the smaller and perhaps unsaleable diameter classes, and a Divisional Forest Officer's comments on a plan that made him go round felling unsaleable poles in order to get his prescribed volume would be more lurid than polite! But without some such proviso it seems an inevitable tendency to take too large a proportion of the total yield from the selection trees, and where then is their safeguard ?

13. It may be argued that Von Mantel's formula (and its various modifications) gives a figure for final yield and not for total yield, and hence the figure of volume yield calculated on this formula can justifiably be removed only in selection trees,—thinnings, etc., below the selection limit being extra. This interpretation has never been adopted in the U. P., and would, I think, be extremely dangerous, as leading inevitably to overfelling of the selection trees. For it must be emphasised that Von Mantel's formula gives approximately accurate results only for a normal proportion of the diameter classes. At present we do not even know what the normal proportion should be,

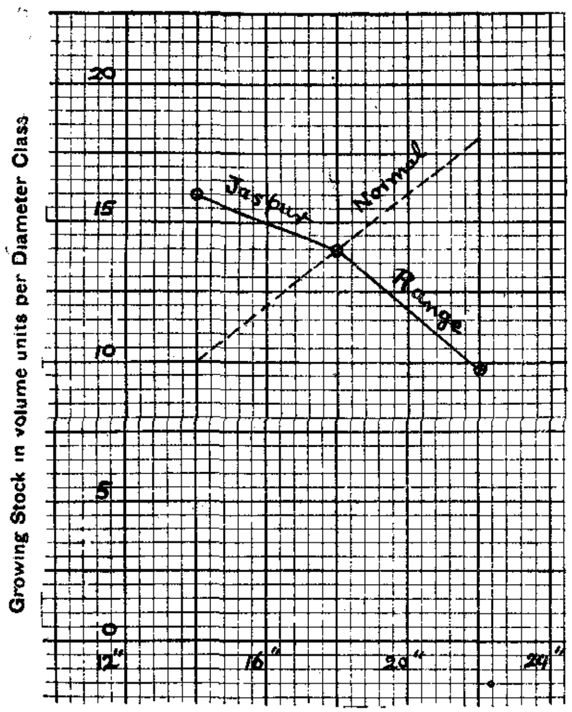
and therefore cannot possibly assume that the actual proportion in our forests is normal. Past history in fact strongly suggests that our present distribution (in most U. P. *sal* forests) must be abnormal, for reckless and uncontrolled felling up to 50 or 60 years ago left thinly stocked forests with relatively few trees that would now have arrived in the selection class, while the flood of young crops that started with protection guarantees an excess up to half rotation age. Thus, while I am doubtful what justification we have at present for adopting Von Mantel at all I feel convinced we have no justification for applying that interpretation of the formula given above.

I can give a concrete example. Von Mantel's formula and its modifications depend for their reliability on the existence of the normal Δ (*vide* diagram below). Surely the whole justification for applying these formulæ is missing where the actual growing stock is a *reversed* Δ ? Actual enumerations over 27,000 acres of Jaspur Range (Ramnagar Division) show the abnormality of a reversed Δ.

Diameter class.	Growing stock in volume units.		Remarks
	Normal forest, say for example in proportion of :	Actual forest per acre.	
12″—16″ ..	10	16	Selection limit for this forest is 20″ diameter.
16″—20″ ..	14	14	
20″ and over ..	18	9·6	

Growing Stock of Jaspur Range

(compared to normal).



Diameter Classes.

The reversed △ is more typical of many of our *sal* forests in the U. P. at the present time than the normal △ and it would be very interesting if any adherent of volume yields would show us *how any volume* yield calculation for the whole forest, down to 12" diameter, can be calculated and applied on the above data of actual growing stock, bearing in mind that we do not wish to sacrifice the excess of the immature middle-aged crops, but rather to nurse them up to maturity, and at the same time their existence must not endanger the sustained selection yield.

Unless some practical solution of this problem is evolved, which meets all criticisms, it seems to me that the case for volume yields applied to such conditions goes by default.

It will, I hope, be conceded that the method of area yields with controlled selection fellings described below is a solution of the problem, as it safeguards the selection yield without sacrifice of immature crops.

14. It may also be argued that the volume yield should ignore the smaller diameter classes (which we do to some extent already), and be based merely on the higher diameter classes. But where

should we draw the line? At 16″ or 20″ or 24″? When we get on into these high diameters, it is rather absurd to talk of a volume yield based on the whole forest.

15. I admit that hitherto area yields have also failed adequately to safeguard the selection tree, but I think it can be done without great difficulty, and an area yield with a check on the rate of removal of selection trees is quite feasible, as was adopted in our *sal* working plans 40 years ago.

It is obvious that the supply of selection trees is adequately safeguarded if in any area the number that may be felled is limited to the number that will pass up from below by the time fellings come round again. I will try and explain briefly a method of applying area yields to *sal* forests, with the safeguarding of the selection trees as a first consideration.

16. *The application of area yields to sal forests.*—From the point of view of management four types of forest must be distinguished :—

A.—Forests where further regeneration is not at present required. These include (*i*) irregular forests with all ages represented and adequate regeneration, *e.g.*, parts of the hill *sal* forests of the U. P., (*ii*) immature forests predominantly poles with a scattered admixture of large trees, *e.g.*, North Kheri.

B.—Forests where regeneration is required but we cannot guarantee it, as we do not know how to get it.
Examples :—
P. B. I type of U. P. Bhabar,
Goalpara, and Upper Bhabar of Bengal.

C.—Forests where we can guarantee immediate regeneration when and where we like, to the normal extent.
Examples :—
Gorakhpur of the United Provinces,
Kurseong of Bengal.

D.—Forests where we can guarantee some regeneration but not to the full normal extent.
Examples :—
Bahraich and Jaspur of the United Provinces,
Buxa of Bengal.

17. In all types the first object of management is the sustained maximum yield of trees over the exploitable diameter. This connotes ultimately a normal distribution of the age classes and normal regeneration. This corozary is however, not of immediate urgency in type A and remains an impossible ideal in type B., while it is possible in type C and partially possible in type D. Since it is so much simpler to guarantee normal regeneration in a concentrated form, obviously a periodic block system of management is indicated for C and D but is inapplicable to A and B.

18. *Type A. Method of management.*—Selection fellings and thinnings as defined in my second article.

The felling cycle (=f years) and exploitable diameter for selection trees are determined, and the whole working circle divided into f annual area coupes, which it is the job of the Working Plan Officer to equalise.

The general definition of the selection working circle includes the following sentence :—" The object of management requires that every tree over the exploitable diameter (subject to any numerical limitation *fixed in the working plan*), should be marked unless there is a definite silvicultural reason for its retention." This sentence makes it perfectly clear that the responsibility for safeguarding the selection yield rests with the Working Plans Branch and not with the Territorial Branch. The Divisional Forest Officer is in fact encouraged to fell every selection tree after the Working Plan Officer has arranged to reserve sufficient to ensure a sustained yield in future felling cycles. This limitation is calculated on a simple formula :—

$$X = \frac{f}{t}\,(y - z\,\%)$$

where x = number of selection trees that may be felled in any coupe,

f = number of years in the felling cycle,

t = period of years for the next lower diameter to pass into the selection class,

y = the number of trees in the next lower class,

z = the percentage of y trees that disappear in t years.

In this formula, f is fixed and y ascertainable by enumerations; t and z can be obtained :—

(*i*) with approximate accuracy by re-enumerations of large sample areas, or statistical sample plots, or

(*ii*) with sufficient accuracy for a first approximation from yield tables (where available), or

(*iii*) very roughly by a consideration of the normality of the existing distribution of the diameter classes.

The valuation of t and z is obviously a matter for further statistical research in which the Central Silviculturist will, it is hoped, be able to assist.

When x has been determined, the limitation on removal of selection trees is best prescribed as a percentage of their number (= X, and ascertained with little trouble by the marking officer) in the coupe at the time of marking, *i.e.*

$\frac{x}{X} \times 100$ per cent of selection trees may be taken and

$100\,(1-\frac{x}{X})$ per cent must be left.

Thus if $x = 60$ and $X = 100$, 40 per cent. must be left and upto 60 per cent. may be taken and should be taken if silviculturally possible.

If t and z have been ascertained with sufficient accuracy, this guarantees against overfelling of selection trees for type A forest, except for abnormalities, *e.g.*, severe wind break, drought, or insect attack. Such abnormalities can be legislated for in a working plan by prescribing a reduction (under the Chief Conservator of Forests' or the Conservator of Forests' orders) in green timber fellings of the year to a corresponding amount.

Or the formula can be used in another way :—

If it is considered desirable to take every selection tree in the forest as markings go round, *i.e.*, 100 per cent. of X, then x must be made equal to X, and the formula will then be used for calculating the correct value of f, the felling cycle, which will ensure this.

19. A point has been raised that even though the selection yield is calculated and safeguarded by the formula, yet it may not be

"silviculturally available"; the interpretation of this expression in the U. P. *sal* forests is that a tree is only silviculturally available if growing in a fairly complete *sal* crop or over young *sal* poles or established regeneration, and is *not* available if, for example, in a small grassy blank or standing over evergreen invasion.

This expression—or rather this interpretation of it—is, I think, a shibboleth in U. P. *sal* divisions, which has lingered on from the time when we all really believed that *sal* regeneration was merely a question of canopy and seed production, and were prepared to sacrifice our selection trees to some extent to guarantee regeneration. But we place no such limitation or interpretation on the removal of *khair* trees in our *khair* selection working circle, nor do the Bengal working plans on their *sal* selection fellings, nor do the Burma plans on their teak selection fellings. To retain a larger percentage of selection trees than the working plan limitation permits requires strong silvicultural justification, which as a general rule I think it will be very difficult to make. If a *mature sal* tree in a gap or over dense *rohini* has failed to produce regeneration, it is not the fault of the tree but of the ecological conditions around it, and the sacrifice involved in leaving the tree to deteriorate is justified only after there is clear evidence that the ecological conditions have recently changed and that regeneration will follow. Usually there is no such evidence, and consequently no silvicultural justification for the sacrifice involved.

It may be argued that although one is justified in taking it that the immediate prospect of natural regeneration in that area from the tree is virtually *nil*, our successors may discover how to effect it, and therefore we should leave the tree on chance. I can see no justification for leaving mature timber to deteriorate, and sacrificing present yield and revenue, on the chance that our successors *may* solve the problem at some future date, and our successors will have no cause for complaint provided we ensure for them a sustained or improving selection yield from the working circle as a whole.

In the exceptional case of a forest with much mature and over-mature timber and a marked deficiency of regeneration and the younger age classes the working plan will have taken the silvicultural

aspect into full consideration. In the more usual case, with plenty of young and middle-aged trees coming on, the retention of selection trees beyond the percentage fixed in the working plan for sustained yield is still more difficult to justify. For we have to realise that if by taking out the prescribed percentage of selection trees we make small or moderate gaps, yet the working circle as a whole is steadily improving and the distant yield is assured. It is almost as much a mistake to underfell as to overfell, and where a Working Plan Officer has fixed the percentage of selection trees that may be felled, the Divisional Forest Officer will have to justify his action if he does not work up to it.

20. The formula for safeguarding selection trees cannot be applied to hopelessly abnormal conditions. For example if in a whole forest there were no trees below the selection limit, or no trees in the next lower diameter class below the selection limit, the formula would give no selection yield. But as there are probably no such forests in India, this scarcely matters. Any method of volume yield would equally go wrong when applied to such abnormal conditions.

21. We must, however, consider the case of a forest which has had no selection fellings for several decades (or possibly never) and which therefore, has an excess of mature or overmature trees. There can never be any justification for safeguarding an *excess* of selection trees in a forest. The safeguarding formula will help us here, by showing us how many trees we may expect to come up to selection size in the felling cycle, and to this we should add on a certain proportion depending on the amount of selection trees we consider excessive and the rate of removal of that excess. (This is practically what the Burma plans do). Similarly if we have a deficiency of selection trees, we should deduct a certain proportion from the per cent calculated by the formula in order to build up the stock towards normality.

22. This at once raises the question—how can we judge whether the existing crop of selection trees in a felling series is in excess or deficit, and how much in excess or deficit ? At present we have no means of answering this ; our yield tables give us a reliable picture of an ideal that does not help, *i.e.*, a fully stocked *sal* forest in regular 10

year gradations. This does not answer the above question. What we want is a table for an irregular or regular *sal* forest, showing the normal proportion per felling series or per acre in 4″ diameter classes (or in whatever dimensions our enumerations of actual growing stock are made), and not in 10 year age gradations. Can the Imperial Silviculturist give us such a table ? If so, it would give us the standard for which we are at present groping.

Having some standard with which to compare our actual forest, we could introduce the necessary allowance (A) for abnormality of selection trees into our formula as follows :—If A represents the % of selection trees that we should

$$\frac{\text{remove to reduce a surplus}}{\text{retain to reduce a deficiency}}$$

then $x = \frac{f}{t}$ (y—z%) ± (A% of X)
and the % of X that we may remove in any selection coupe = $\frac{x}{X}$ x 100 ± A.

(This figure A can also be used in another way, as mentioned in para. 26 below. For if in any working circle we have a combination of concentrated regeneration in Periodic Blocks, combined with selection felling in the later P. Bs., the selection yield from the latter gradually decreases during the rotation as the area already regenerated increases. To counteract this, we can use A to insure that in the later P. Bs. we have a larger number of selection trees per acre in the regeneration coupes and therefore a greater revenue from the regeneration coupes, tending to counteract the drop in the selection coupes. If in a selection working circle A was 0, in a combined clearfelling and selection working circle it could be given a negative value.)

23. It is advisable to point out that by basing the yield as a percentage of the number of selection trees in any year's coupe *at the time of marking*, we automatically allow for increment. A Working Plan Officer who made his *f* annual area coupes so as to include equal numbers of selection trees at the commencement of the felling cycle, would actually be arranging for a steadily increasing yield throughout

his felling cycle, as increment would add about 1 to 3 % per annum to the number of selection trees standing in a coupe as each year passed. This indicates the necessity for some adjustment, *e.g.*, in a uniformly irregular forest that the earlier/later area coupes should be slightly larger/smaller in area than the average. It also requires a study of the distribution of the lower diameter classes in the later coupes to ensure against a drop in yield in later felling cycles.

24. I have perhaps not made it sufficiently clear that the safeguarding formula necessitates enumerations on an adequate scale to tell us fairly accurately the proportion between the number of trees in the selection class and in the next lower class. (In the United Provinces where we are plagued with large hollow unfit and therefore practically valueless *sal* trees, these are enumerated separately and altogether ignored in the calculation. Hence the term "selection tree" does not mean *all* trees over the selection limit.) Actually we enumerate in standard 4″ diameter classes (12″-16″, 16″-20″, 20″-24″ and 24″ and over) and if our selection diameter is not exactly 20″ or 24″ we have to make necessary adjustments on a curve. The introduction of two selection diameters in one working circle (which we are sometimes forced to have to allow for marked variations of quality) brings in a complication which we have not yet solved altogether satisfactorily in applying the safeguarding formula.

The control of this formula as a working plan prescription is a fairly simple matter. The marking officer records separately the selection trees marked and all selection trees left unmarked, and both sets of figures are recorded in control forms and compartment histories, and the actual percentage left can easily be checked both by the Divisional Forest Officer in the forest and by the Control Form Checking Officer in office.

25. *Type B.*—Since regeneration cannot be guaranteed, the only possible method of management applicable is selection fellings and thinnings as for type A, with the same limitation on removal of selection trees. But as regeneration is urgent, some attempt at least must be made to obtain it, and the best means of ensuring this,

without disorganising future management if we fail, is to set apart a specific area to be regenerated, if possible, during the working plan period, and to be excluded from selection fellings altogether. From this area the Divisional Forest Officer will be able to obtain an additional yield (and revenue) if or when he obtains regeneration or can guarantee to obtain it immediately artificially. If experiments in obtaining natural regeneration are required which involve fellings, they *should be limited to a 50 acre scale. The area set apart for regeneration* should not exceed 25 or 30 % of the area which should be regenerated normally in the working plan period. If conditions suggest the advisability of including a greater area for regeneration, the inference is that the regeneration problem must already have been solved to some extent and the forest should then be allotted to type D.

26. *Type C.*—With the power to regenerate when and where we *wish the following example will illustrate a suitable method of* prescribing the yield by area for this type. Rotation 80 years, with four P. Bs. of 20 years. P. B. I divided into 20 annual clearfelling coupes by reduced area (*i.e.*, to give equal outturn) if possible. If, however, equal acreage is essential, and fluctuations of outturn unavoidable, these fluctuations will be evened out by adjustments in the coupes of the other P. Bs. *e.g.*, a poor P. B. I coupe will coincide with a good coupe in P. Bs. III and IV. If small material is unsaleable, sacrifice can be avoided by leaving smaller stems as the future crop, provided this does not interfere with the regeneration of the rest of the coupe.

P. B. II.—Thinnings only and no selection fellings, by annual area coupes, corresponding to the felling cycle, which need not necessarily coincide either with the period of the block or of the working plan.

P. Bs. III and IV.—Similar annual area coupes, but with selection fellings (controlled by the same formula and limitation as described above) in addition to thinnings.

The reason for excluding selection fellings from P. B. II is to ensure a good yield when the area comes into P. B. I, and also to compensate (in part at least) for the reduction of selection fellings in

the next period, *i.e.*, when P. B. II becomes P. B. I, selection fellings will be in P. B. IV only. When P. B. III comes to be regenerated, there will be no selection fellings, but to compensate we shall probably have saleable thinnings from P. B. I. Or, the areas allotted to different P. Bs. could vary, the area increasing somewhat for the later P. Bs. Or, we could modify A of the formula (*vide* para. 22) to insure a larger concentration of selection trees per acre in the later P. Bs., to compensate (by a more valuable regeneration coupe) for a decrease in the selection coupe. Selection trees outside P. B. I are really surplus growing stock, the removal of which will have been spread over half a rotation, and when the removal of surplus stock is completed, some reduction of the yield is usually inevitable. The scheme outlined above introduces compensatory tendencies to counteract this reduction and definitely guarantees a sustained yield of selection trees from the regeneration fellings for the whole rotation, provided the growing stock on all P. Bs. is much the same.

27. *Type D.*—The management and yield prescriptions for this type will be the same as for type C except that we must legislate for possible underfelling in the regeneration coupes. Thus if the full area of the clearfelling in P. B. I is not reached, an automatic adjustment for varying possibilities is required, and the following proviso in the working plan will, it is believed, be sufficiently accurate :—

> "In any year when the P. B. I coupe is not fully felled (owing to difficulties of guaranteeing regeneration), selection fellings with the usual safeguard will be made in an area of P. B. II equal to the area unfelled in P. B. I."

This selection felling will not compensate entirely for the reduced yield in P. B. I, and quite rightly, as the normal area will not be taken up for regeneration, but it will tend to compensate. That it will not be overfelling is obvious, since any deficit in the P. B. I clearfellings means a correspondingly longer time for P. B. II to pass into P. B. I and therefore correspondingly larger accumulated increment and growing stock. Thus if only half the P. B. I coupe is felled each year, it will mean 40 years instead of 20 before clearfellings commence in P. B. II. Alternately any deficit P. B. I fellings could be carried

forward, and utilised as opportunity arose. This would probably be a better alternative. Obviously *both* alternatives would be inadmissible.

28. Applicable to all types would be special provision for dry timber fellings on a shorter cycle, by area, where such provision is necessary. If a high mortality is *normal* for any particular forest, (*e.g.*, the moribund *sal* areas of Bahraich and the evergreen invaded *sal* areas of Buxa), the Working Plan Officer will make necessary adjustments by taking a proportionately high figure for z in the formula. Incidentally he would be almost forced to adopt a conversion period shorter than the normal rotation for any forest of type C or D with a high mortality. But no conceivable system of yield control can meet the case of a dying forest, which cannot be regenerated.

29. I might now point out that the scheme of area yields outlined above for the three types B, C, D is really a "Conversion-to-uniform" system, the conversion period being made dependent on our capability of guaranteeing regeneration, and not *vice versa.* The important selection yield is safeguarded and the scheme has the necessary reduction of selection yield as the regeneration yield increases. It also safeguards against underfelling which is almost as much a mistake as overfelling, and it reduces sacrifice of immature trees and loss of increment resulting from regeneration operations to a minimum. I think I may claim therefore that it is a definite advance on our standard "Conversion-to-uniform" system as applied hitherto to *sal* forests, as well as on our past management of selection working circles, whether with a volume yield or simply by area.

For A type forest, the attempt to conversion-to-uniform is postponed until the area requires it, and until the sacrifice involved in premature conversion is avoided.

30. Adherents of the volume yield will certainly ask why cannot the limitation on removal of selection trees be applied to volume yields calculated on increment and/or growing stock of the whole forest. This is in effect practically what I have suggested that some adherent of a volume yield should do in the concrete case of the Jaspur forests given in para. 13. Most of the objections to the application of volume yields (based on *total* growing stock) to our abnormal *sal* forests would

disappear if a correct and *practical* solution is worked out for the case of a reversed triangle, which ensures that the selection yield is not endangered and immature crops are not sacrificed.

31. I will anticipate two obvious criticisms of the safeguarding formula. The first is that it requires as much data from enumerations and more statistical data for estimating t and z than volume yield formula, and is therefore more liable to go wrong.

I have explained in para. 13 that no modification of Von Mantel's formula is really dependable in irregular and abnormal forests, and in para. 12 that any total volume yield, calculated on increment or total growing stock, is inapplicable when smaller size material is of low value or unsaleable, since the proper reduction that should be made for unsaleable thinnings defies calculation in our irregular forests.

The Bengal formula illustrates this difficulty and in addition requires calculation of the increment of the whole existing growing stock over a rotation—which I believe is an impossible calculation in our present state of knowledge. This at least can be claimed for the safeguarding formula, that as it is based on one diameter class only, any error is likely to be less serious than the corresponding error applied to the growing stock of a whole forest, and it does definitely eliminate the proportion of yield that must be allotted towards unsaleable thinnings. Finally it is applied as a check on area yields, while a yield prescribed simultaneously both by volume and area is not feasible. Every Divisional Forest Officer, particularly a new Divisional Forest Officer, knows exactly where he is with an area yield and therefore prefers it. Also any error in a volume yield is cumulative, in an area yield it is distributed.

32. The second criticism is that it is merely a modification of Brandis, a method of yield calculation that gradually became a standard method throughout India, and was then largely given up. To quote from the proceedings of the Punjab Forest Conference 1931 :—

> "Everything looked very nice in the working plan, but when one went to carry it out, one found that the trees did not grow, neither were they distributed, in accordance with the mathematical table given in the plan. That was the great failure of the

Brandis system *when applied to the whole working circle.* If yield calculation had been done compartment by compartment, better results would have been obtained."

My answer to this possible criticism is partly given in the above extract. Although the rate of removal of selection trees is calculated for the working circle as a whole, the device of fixing the percentage of trees to be removed on the number standing at the time of maiking does apply it compartment by compartment, or rather coupe by coupe, and therefore tends to avoid " the great failure of the Brandis system."

I clearly realise that in actual practice we cannot attempt to guarantee a sustained selection yield for each individual coupe from one working plan period to another and simultaneously get an equal annual yield for the different coupes in the working plan, since the proportion between x and y usually varies considerably in different parts of a working circle. But I can see no radical objection in this, as with regular working plan revisions, the annual area coupes can always be readjusted as found advisable, and our object of management is met if we aim at a safeguard per felling series. Having as far as possible avoided the " great failure " of the Brandis method, I would add that my proposals have incorporated the great success of that method, *i.e.*, that the *total* volume yield was ignored altogether, and calculations concentrated on the sustained selection yield, which is all that matters in most of our forests in India.

A further criticism on Brandis and similar methods is that calculations were made on extremely inadequate data of rates of growth, and % of trees passing from one diameter class to the next. This is a perfectly true criticism, but it can scarcely be denied that thanks to the research work of Imperial and Provincial Silviculturists from the time of Troup onwards, we are in a much better position to-day than the early generation of foresters, and I have emphasised in paras. 18 and 22 above the importance of collecting further statistical data. This criticism is therefore one that we can in time get over, and I think our present state of statistical knowledge justifies us carrying on until the next working plan revision 15 years hence.

33. In this article I have referred almost entirely to *sal* forests, but the underlying ideas apply to any irregular and abnormal forest where selection trees are important, and a sustained yield of them is required. In conclusion, I might summarise the principal points of this article :—

(*i*) The chief object of management in most Indian *sal* forests should be a sustained yield of selection trees and not a sustained total yield of large and small timber together.

(*ii*) The conversion system (as hitherto practised) failed to safeguard the selection yield, as the chief object of management was the rapid production of even-aged groups or blocks. It made the rate of natural seedling regeneration dependent on the conversion or regeneration period—a fundamental mistake for a species such as *sal*—and not *vice versa*. It involved a large loss of increment, where natural regeneration failed or was slow to follow the fellings.

(*iii*) No volume yield yet evolved can by itself safeguard the selection yield. To remove such a yield in selection trees only is usually unjustifiable, and the allotment of a certain percentage of the volume yield to thinnings (possibly unsaleable) or to removal of surplus immature crop is difficult to calculate and not practical in Indian forest conditions.

(*iv*) Area yields by themselves also will not safeguard the selection yield, but an area yield can be combined with a check on the rate of removal of selection trees, which introduces the necessary safeguard, both against overfelling and underfelling.

(*v*) The system of area yields with a check on the selection trees can be applied to all types of forest and eliminates as far as possible the objections pointed above to our present systems of management.

For all these reasons I believe the safeguarding formula applied to area yields is less liable to go wrong than any volume yield method of yield hitherto adopted.

WIRELESS FOR THE FOREST OFFICER.

By G. M. Hopkins, I.F.S.

It may interest other Forest Officers to know that they can, with comparatively little trouble, get plenty of amusement and entertainment from a wireless set in camp. At times, particularly during the hot weather, the long evenings in camp are rather boring, and it is with the object of alleviating such boredom that I am taking the unprecedented (for me) step of rushing into print.

Let me say, first of all, that I am a complete tyro. While home on leave I have found plenty of amusements apart from wireless, and have hardly ever even listened-in to other people's sets. In March this year, the thought of the approaching hot weather in this very dull district decided me to take up some new hobby, and a Calcutta firm's advertisement in the newspaper inspired the purchase of what is called " A four-valve all wave set." The cost of the complete set is Rs. 275/-, and full directions, which are easy to follow, are supplied. Wireless " fans " will please note that this is written for the complete novice, so the actual procedure adopted in getting a set of the above description ready for receiving programmes is given in some detail.

To start with, a copper wire, 80 to 100 feet long, called the aerial, is fixed to porcelain insulators and stretched, about 20 feet above the ground, between two convenient trees in the compound. Another wire is attached to it and led to the set. A kerosine oil tin is then buried in the ground with a wire, called the " earth " connecting it to the set. The set referred to is a wooden box, size 19″ by 10″ by 8″, full of wires and strange looking pieces of apparatus which rather frighten one at first. However there are only four valve-holders into which to put the valves and three coil-holders for the coils. It is hardly possible to make any mistake in putting these in, and, once in, they can remain in. Various other clearly marked wires are then plugged into the two dry batteries supplied, and all that remains is to attach the loudspeaker or the headphones.

Wireless programmes are broadcast on " waves " of various lengths, measured in metres. These fall into two main divisions,

long waves and short waves. Long waves proceed along the surface of the ground, following the curvature of the earth, and are efficient over only comparatively short distances. In the U. P. these direct rays, emitted by the Calcutta and Bombay long-wave stations, are so badly affected by atmospheric disturbances that they give very poor results. Short waves, however, proceed upwards into the higher strata of the atmosphere and are reflected from there, thus avoiding all except quite local disturbances. As these indirect rays take only about a tenth of a second to travel right round the world, it makes no appreciable difference whether one is a thousand or ten thousand miles from the broadcasting station. The speed with which wireless waves travel is so great that the listener in India hears Big Ben striking before the sound of the chimes reaches the passer-by on Westminster Bridge !

Forest Officers, who mostly live some hundreds of miles from the nearest Radio station, will therefore find short waves more satisfactory than long waves. The British Broadcasting Corporation has recently made special arrangements for listeners in various parts of the Empire, and radiates daily programmes on short waves for the Indian Zone, which includes Burma, Ceylon, and Malaya, from 1-30 to 5-30 p.m. (Greenwich Mean Time), *i.e.*, from about 7-0 to 11-0 p.m. in the U.P. These programmes cater for all tastes, but if listeners dislike any particular items they have an immediate and effective remedy, to wit, switching off the set and writing letters of complaint to the B. B. C.

Having got the set ready, and having taken the very necessary precaution of making sure, from the Radio programme in the newspaper, that a programme is actually being radiated at that time of day, the listener-in has to tune in on two rotatory dials, marked off in degrees. One dial controls the wave-length and the other the volume of the signals received. The volume dial is turned until a noise sounding like heavy rain is heard, and the other, or tuning dial, is then turned slowly until a programme is received.

We now come to the only difficult part of the whole procedure, which is to turn the tuning dial sufficiently slowly and delicately. In our youth, during the hours we spent, or should have spent, cutting "thin grey sections" of *Pinus sylvestris*, or dissecting the common

earthworm, whose scientific name I have most unfortunately forgotten, *we laboriously acquired a certain delicacy of touch. We can* now realise the true advantages of a University education, and call our hard-won skill into play. The tuning dial must be turned a fraction of a degree at a time, as an almost infinitesimal movement may result in a station being completely passed over; for example, Paris and London are both within the same degree marked on the dial. But once a station has been received it can be found again by noting the dial reading in degrees that brings it in, and the volume of reception can be regulated by the other dial.

My experience has been that, provided the instructions are carefully carried out, programmes are regularly received. There are disappointments of course, the worst one so far being during a very exciting running commentary on the England *v* Scotland rugger match, when a rather ham-handed person was too anxious to help, and the voice faded away and could not be picked up again in time to hear the final result.

Generally speaking the news announcements at the beginning of the programmes are not very clear, owing, it appears, to unfavourable atmospheric conditions early in the evening.

If, however, one particularly wants to hear the news, it can be heard at about 10-30 p.m. from Paris (in English), or again from the B. B. C. station towards the end of the programme, this repetition being a recent innovation. Usually reception gradually improves up to about 9-0 p.m., and is then quite satisfactory until Big Ben strikes the half-hour, at 6-30 p.m. British Summer Time, to end the programme.

The programmes include talks on many different subjects, and all sorts of music from jazz to the choir and organ of Westminster Abbey. Towards the end of the British programme, Paris and Rome begin broadcasting, and as there are several dozen shortwave stations elsewhere, the real enthusiast can listen-in all night. The items that come through best are dance music and cinema organ recitals, though more classical music is also received quite well. Running commentaries on such National events as the Soccer Cup Final at Wembley, the

Grand National, the Boat Race, the Trooping of the Colour, the Derby, and so on, can be easily followed.

Having arranged for an overdraft large enough to pay for the set, the owner has few other expenses. The B. B. C. periodical, "World Radio," costs 5d. a week (post free), and contains, besides all the Empire programmes, much interesting and instructive information. It can be got from booksellers in India, or direct from the B. B. C. Broadcasting House, London. Of the two dry batteries, the larger costs about Rs. 14/-, and should last about five months, while the smaller, costing Rs. 4/8, needs to be replaced after a month's or six weeks' steady use. The latter would ordinarily be a wet battery, or accumulator, but most Forest Officers will have to use dry batteries owing to the difficulty of getting accumulators re-charged.

Finally, may you soon be crawling under your mosquito net, having set your watch by Big Ben, with the words of the B. B. C. announcer echoing round your failed P. B. I.

"Good-night everybody. Good-night."

PLANT PATHOLOGY IN THE FORESTS OF INDIA.

PART I.—BY R. S. HOLE.

1. In the *Indian Forester*, Vol. 25, November, 1899, p. 431, Mr. J. S. Gamble published an article *On the determination of the Fungi which attack Forest Trees in India* in which he pointed out how little progress had been made with this subject and urged Forest Officers in India to collect specimens of fungi and send them in for identification. Again, in the *Indian Forester*, Vol. 31, February, 1905, p. 85, Mr. Gamble wrote as follows: "Of course! botany is well taught at Coopers Hill; whether it has always been quite the sort of botany that is wanted for our purposes is another matter, but as the college is so soon to cease to exist, it is not now worth while further to discuss the subject. I might, however, make the remark that, although Professor Marshall Ward is one of the highest authorities on the fungoid diseases of trees and must have taught about them to some extent, but one of his old pupils, so far as I know, has yet attempted to pursue

the subject in India." In the latter paper Mr. Gamble did not, I think, quite grasp what seems to me to have been the particular point then at issue, *viz.*, that, although systematic botany is essential as one of the foundation stones on which the edifice of forestry is built, still this is not the only branch of botany necessary for the welfare of forestry, neither is the opinion of the professional systematist, particularly the botanist whom we may call the herbarium specialist, always necessarily the most valuable opinion on the botanical subjects which are most important for the progress of successful forestry. Mr. Gamble justly urged that "we must begin by searching for and finding the sporophores and obtaining their identification," but he appears to have overlooked the paramount necessity of improving our knowledge of those fungi which had, already, long been well known to systematists and which were generally believed to be highly injurious to valuable forest species, with the object, if possible, of materially diminishing, even if not indeed entirely eliminating, the damage done by them. At the same time, no competent forest officer would, I think, now dispute the soundness of what I believe was the foundation of Mr. Gamble's main contention, *viz.*, that a good forest officer must be thoroughly trained in those branches of botany which are of real importance in economic forestry.

2. The late Professor H. Marshall Ward took great pains to impress on his pupils at Coopers Hill a broad view of the subject of plant disease, the great importance of studying not only those organisms which are usually believed to cause disease but especially those conditions which encourage and promote normal healthy growth, as well as the real meaning and significance of the struggle for existence in this matter. Consequently, during my subsequent training in the forests of Germany in 1896, I was greatly struck by the way in which the incidence and severity of the *Schütte* disease (associated with the fungus formerly known to foresters by the name of *Hysterium pinastri* but now generally called *Lophodermium pinastri*) of Scots Pine appeared to depend, so far as I could judge by the observations I was able to make in the forest, on the varying factors of the environment and especially on the extent to which the seedlings were exposed to

damage from frost or drought. I wrote a short note on the subject and sent it to Professor Ward for his opinion. If for no other reason than that it illustrates so clearly the great interest which Professor Ward took in his students and in their scientific work, it seems desirable that the following extracts should be quoted from the letter which he wrote to me on the subject, on October 25th, 1896 :—

> "So far from regarding your letter and request as presumptuous, I take it as a great compliment that you should so esteem my opinion and am very glad indeed to look at your essay. I have carefully read it, and am very pleased indeed with it, not because it convinces me entirely (for it does not) but because it shows so clearly that you have carefully observed things, and recorded them in a truly scientific spirit, and for those reasons the paper has value as an original contribution. I take some pride, too, in having had a hand in getting you to see so clearly the meaning and importance of the struggle for existence in these matters. I am sending you a copy of a paper—reprint of a lecture of mine, given some years ago to the Royal Society,* in which you may find some ideas showing that your notion of the co-operation of predisposing causes in such diseases is by no means improbable or ill-founded. I shall look forward to your doing some good work in natural history. If you only record what you see and think, I shall not be disappointed."

In the paper alluded to, Professor Ward stressed a point which has frequently been emphasized by subsequent investigators, *viz.*, that the power of a fungus successfully to attack a given plant depends largely on the mode of nutrition of the fungus and that, in many cases, a fungus can, as it were, be educated to become a strong parasite by being cultivated first on dead or sickly tissue. Thus the presence of dead, weak or sickly, tissue in a plant is doubly dangerous, first because it may enable a fungus to obtain its first foothold in the plant, which it would be unable to do in the absence of such sickly tissue, and secondly, because it may actually increase the vigour and power of the fungus feeding upon it to attack and destroy the normal healthy tissues

* Croonian Lecture, read February 27th, 1890.

of the same plant and to infect additional normally healthy plants. Again, the ability of a plant to resist the attacks of an injurious fungus depends largely on the power of the protoplasm rapidly to construct layers of protective cork as a barrier against the invading hyphae and to control and render innocuous poisonous substances excreted by the fungus. Any factor which depresses the activity of the normal metabolic processes, such as a deficiency of oxygen or water, therefore, is likely to render a plant more liable to be overcome by the attacks of injurious fungi. It must be remembered, also, that tissue which is alive is by no means necessarily vigorous or in normal health.

3. Ten years' experience subsequently gained as an executive and educational officer in the forests of central and northern India impressed on me the primary importance to the health of plants of such environmental factors as water-supply, temperature and soil-aeration, all of which can, to a great extent, be controlled and regulated by the ordinary operations of practical silviculture; but regarding the action of which, in the case of our Indian forest species, practically no precise detailed information at all was available. It seemed probable, therefore, that a careful study of such factors and their effects on the health of plants would lead to the adoption of improved silvicultural methods which would result not only in an increased capacity to resist all forms of disease on the part of our forest species but also in the introduction of conditions definitely unfavourable to the development of disease-producing organisms.

4. When, therefore, I was appointed Forest Botanist, in May 1907, I decided to attack this subject on the following lines :—

(1) To concentrate attention on a few really serious diseases with the object of trying to bring these definitely under control, rather than attempt to specialize as a systematic mycologist and dissipate energy in widely collecting and studying, chiefly from a systematic point of view, large numbers of fungi which under existing conditions appeared to be of no immediate practical importance in Indian forestry;

(2) to study each disease, so far as possible, under all the conditions under which it occurred in the forest and to gain some idea as to whether or not these conditions were definitely unfavourable to the general health of the trees attacked, or especially favourable to the development of the fungi concerned;

(3) to make a detailed study of certain ecological factors, such as water-supply, soil-aeration and temperature, especially with the object of ascertaining the degree of intensity at which such factors first begin, definitely to influence unfavourably the normal functions of the plants and of obtaining a more complete knowledge of how these factors may be controlled in silvicultural practice.

It seemed to me in fact that, while silviculture was to a large extent being carried on empirically with little or no real knowledge of the fundamental principles concerned, mycology, on the other hand, was to a large extent out of touch with the conditions and needs of practical forestry and that what was really required was to bring the two branches of study into closer touch both with each other and with realities by making silviculture, as it were, more intensive and mycology more extensive. This point of view was by no means generally accepted at the time, either within or without the Forest Department, and there were many who held that the study of plant diseases must be undertaken by specialists in mycology. Fortunately, however, some at least of my official superiors more or less agreed with my ideas, as will be seen from the following abstract from Mr. L. Mercer's *Progress Report of the Forest Research Institute* for the year 1910-11, p. 2—"when the post of Forest Botanist was created, the principal duty prescribed for the incumbent was that of studying the diseases of our important forest species. It was believed that the most valuable results in this direction would be obtained rather by studying the physiology and ecology of our important trees than by specializing in mycology. The writer fully concurs with above and the results now coming to hand already bear out this view."

5. That greater progress was not made during my tenure of the post of Forest Botanist in the study and control of the diseases of

Indian forest species has been due primarily to lack of the necessary staff and facilities. Until December 1921, when Mr. R. N. Parker joined the branch as Systematic Botanist, the Forest Botanist was the only imperial gazetted officer on the permanent staff of the botanical branch of the Forest Research Institute at Dehra Dun and he was accordingly obliged to devote a great deal of his time to educational work, to systematic work (including the organization and upkeep of a botanical garden, library and herbarium, and the identification of specimens for forest officers and others) and to general ecological problems. In September 1915, Mr. Abdul Hafiz Khan joined the branch as an Assistant and from that date it was possible to devote more time to problems of plant disease. As regards the general policy governing these matters during the period now being considered, the following extracts from the Progress Reports of the Forest Research Institute are of interest :—

(*a*) From the Report for the year 1907-08, p. 2— "The time available for research work was of necessity considerably restricted by the educational work that the Botanist was called upon to undertake at the College," and p. 5—" the work in connection with the college which is the first charge on the Institute, restricts research in every direction ; "

(*b*) from the Report for the year 1913-14, p. 1—" It is the clearly expressed policy of the Government of India that one of the dual objects for which the Research Institute was founded was to give a high class education and that this was to have priority over research ; "

(*c*) from the Report for the year 1911-12, p. 3—" This identification work has to be done entirely by the Botanist as there is no one else capable of it, and takes up a very large amount of his time. At the same time the President considers it to be of the first importance, as it keeps the Research Institute in touch with the department and indicates to the latter that the Botanist is doing his best to help it at much inconvenience to himself. This promotes cordiality and confidence between the Institute and officers of the department which would be the case to a far lesser extent if officers had to send their specimens for identification elsewhere."

6. Notwithstanding the difficulties in the way, however, considerable progress was made during the period 1907—1923 in the study of the principal diseases of important forest species in India and I propose to deal with the chief results which were obtained in a subsequent article.

TAUNGYA PLANTATIONS IN THE SAHARANPUR FOREST DIVISION, U. P.

BY M. P. BHOLA, I.F.S.

The forests of the Saharanpur Division form the northern boundary of the Saharanpur District, where it is rather thinly populated. The area of the forests is 301 square miles, of which 209 square miles are on the southern slopes of the Siwaliks and 92 square miles in the plains. Of the latter, 63 square miles is on dry poor Siwalik *bhabar* formation and 29 square miles in moist *tarai* or semi-*tarai*. The average annual rainfall is 43 inches, most of which falls between 1st July and 30th September, the total fall in the remaining months of the year being only 4 inches. May and June are very hot, the temperature rising up to 115 degree F.

The area in the plains (92 square miles) consists of—

(*a*) The Sal Working Circle—18 square miles.

(*b*) The Miscellaneous Working Circle—11 square miles.

(*c*) The Grazing Working Circle—63 square miles.

(*a*) *The Sal Working Circle.*

2. In this working circle, generally an open *sal* of poor quality with an under-storey of the miscellaneous species and heavy undergrowth of grass and shrubs occurs. *Sal* regeneration is conspicuous by its absence. During the last 4 years, heavy mortality among *sal* has occurred owing to continued droughts. The mortality is so heavy that in some compartments not one healthy *sal* tree is to be seen anywhere. The system of management is Improvement Fellings.

From 1923 to 1930, ordinary plantation work was done in this working circle and teak (*Tectona grandis*), *sissoo* (*Dalbergia sissoo*),

khair (*Acacia catechu*), *sal* and other species were tried. In one particular wire-fenced area of 200 acres (Ganjarban block) about Rs. 14,000 were spent, but without any success. In 1931, this plantation was abandoned.

(*b*) *The Miscellaneous Working Circle.*

3. It generally consists of an open crop of the miscellaneous species with heavy grass underneath. Prior to the present plan, the system of management prescribed was coppice with standards, which failed to achieve its object. The coppice failed to come up and the areas were invaded by a dense growth of *kapasi* (*Helicteres isora*) and tall grasses instead. Fellings in this working circle had consequently to be suspended under the current plan until some means of regenerating the areas were found. Plantations on an experimental scale were started, which in spite of heavy expenditure, failed to produce satisfactory results.

(*c*) *The Grazing Working Circle.*

4. The remainder of the area in the plains is included in the Grazing Working Circle, of which the main object is to provide permanent grazing grounds to the adjoining villages of the district and to professional graziers, the fellings being restricted to the removal of only dead and dying trees. The areas consist of scattered trees mostly of the miscellaneous worthless species with moderate to heavy undergrowth of thatching and fodder grasses.

5. Prohibitive cost of plantations and the element of uncertainty which attend their success led the writer, during his first tour in the division in the winter of 1929-30, to investigate the possibility of introducing *taungyas* in these areas. As a result of this, a scheme to introduce *taungyas* in this division was submitted to the Local Government early in 1930. The sanction of the Government was received in April 1930 and immediately afterwards, 121 acres of land was distributed among villagers ; 75 acres in the *tarai* area of the Pathri block and 46 acres in the dry hot Siwalik *bhabar* of the Baniawala block, both in the Grazing Working Circle. The cultivators were

mostly of the poorer classes, called *chamars*, from the neighbouring villages who had little or no land to cultivate. They started preparing the land in the *taungyas* with unexpected quickness and were well in time to sow their *kharif* (rainy weather crop) by June 1930. This was reaped in the following October and soon after the *rabi* (winter crop) was sown which was reaped in April 1931. The soil by now was well worked and ready for forest species. Consequently in May—June 1931, lines 18 feet apart were made by the cultivators. These lines were dug one foot deep and one foot wide and the dug earth was heaped alongside the lines and allowed to aerate for about a fortnight after which it was put back into the ditches. After a couple of good showers the forest species were sown in July 1931. The period which followed was characterized by a severe drought which caused a heavy mortality among the young seedlings. The areas were re-sown by the end of July when rains set in again. The cultivators were also busy ploughing up their land in the 18′ wide strips between the line sowings and they put in their second *kharif* crop as usual in June. The following forest species were sown—

(1) *Tarai* area, Pathri block :—babul (*Acacia arabica*), *khair*, *sain* (*Terminalia tomentosa*), *teak*, *siris* (*Albizzia lebbek*), *sissoo* and bamboos.

(2) Dry hot, *bhabar* area, Baniawala block :—*khair*, *sain*, *sissoo*, *siris*, bamboos and *sal*, the last named species being sown only on two lines just as an experiment.

Almost all the species came up quite well but some teak and bamboo seedlings were killed by water logging in the Pathri block, while most of the *sal* and bamboo seedlings disappeared owing to excessive drought in the Baniawala block. The lines of *babul*, *khair*, *sissoo*, *sain* and *siris* are now about two years old and are densely grown and up to ten feet high. Light thinnings have been done in some of the very congested *babul* lines. Thinnings in the *khair* lines are also indicated and should be done in a year or two. The remaining teak and bamboo are quite good and fully established. The few seedlings of *sal* now surviving are up to 3 feet high, deep rooted and are expected to withstand successfully the effect of any future

Terminalia tomentosa 2 seasons' old with background of *Acacia catechu* of same year : Saharanpur Division.

Photo Harswarup
December 1932.

Acacia catechu 2 seasons' old *taungya* sowings with wheat in Saharanpur Division.

Photo Harswarup
December 1932.

droughts. These sowings of forest species in July 1931 mark the beginning of the *taungya* plantations in the Saharanpur Forest Division.

6. The sympathetic treatment which the cultivators got from the Forest Department and the excellent agricultural crops which they obtained in the virgin forest soil attracted many more villagers to our *taungyas*, and there was such a rush at the time of the distribution of land in 1931 and 1932 that we had to raise the premium on land from 4 to 8 annas per acre and even then a large number of the villagers had to go back disappointed as they could not be accommodated.

The satisfactory results obtained from the 1931 sowings encouraged us to place larger areas under the *taungya* in 1931 and in subsequent years. Forest sowings done in the rains of 1932 have yielded as good results as those obtained in 1931. The following areas in the Grazing Working Circle are under *taungya* at present.

	Acres.
(*a*) Placed under *taungya* in 1930 ; forest sowings in 1931	121
(*b*) Placed under *taungya* in 1931 ; forest sowings in 1932	186
(*c*) Placed under *taungya* in 1932 ; forest sowings to be done in 1933	311
(*d*) Placed under *taungya* in 1933 ; forest sowings to be done in 1934	727
Total ..	1,345

7. Having definitely passed the experimental stage, a scheme has been drawn up now laying down the object of the *taungya* plantations in the Grazing Working Circle and the forest species to be sown to obtain the object have also been indicated. The *taungya* plantations in this Working Circle aim at improving the grazing for the cattle of the adjoining villages and leaf fodder for the buffaloes of the *Jammuwala Gujars*. The *Jammuwala Gujar* is a professional grazier. He takes his buffaloes to the hills during the summer months and brings them down to the plains in the cold weather. His buffaloes

having got accustomed to the succulent grass which grows in the hills, refuse to touch the dry fodder grasses which obtain in the plains, and consequently have to be fed on leaf fodder. In the six months that he lives in the plains he pays Rs. 4 per buffalo for grazing and lopping. One acre of the forest with a suitable supply of the leaf fodder and grazing is sufficient to maintain one buffalo for six months. In other words, a forest created with the help of *taungya* and specially managed for the *gujars*' lopping on a 3 years' rotation, will yield Rs. 4 per acre per annum which is more than what most of the forests of this type generally yield. Apart from the fact that the creation of these plantations at a negligible cost to the Department is a sound financial proposition, they fulfil the crying demand of the grazier and ensure incidentally, a plentiful supply of milk products, the importance of which to the health of the nation needs no emphasizing. Grazing is likely to improve when these areas are better stocked and with the introduction of fodder grasses on 18 or 20 feet wide strips, it will be possible to accommodate village cattle which need no leaf fodder on smaller areas than is the case at present.

To obtain this object, the following species will be sown in the *taungyas* in lines 20 feet apart. This interval between the lines, it is hoped, will give sufficient room for the development of the leaf fodder producing crowns of trees and for the propagation of fodder grasses between the lines —

(1) *Khair* (*Acacia catechu*).
(2) *Bakli* (*Anogeissus latifolia*).
(3) *Kairwal* (*Bauhinia purpurea*).
(4) *Bahera* (*Terminalia belerica*).
(5) *Sain* (*Terminalia tomentosa*).
(6) *Poola* (*Kydia calycina*).
(7) *Padal* (*Stereospermum suaveolens*).
(8) *Siris* (*Albizzia lebbek*).
(9) *Sissoo* (*Dalbergia sissoo*).

Khair leaf is loved by buffaloes more than anything else and the tree is also valuable for the manufacture of *katha*. The management of the forest created by means of *taungyas* can be so arranged that

khair can be made to serve both these purposes, thereby making a further increase in the revenue. *Sissoo* is not a leaf fodder tree but small quantities of it will be sown for the supply of timber to the *taungya* cultivators for their carts, ploughs and other agricultural implements.

8. The object of the *taungya* will be quite different in the *Sal* and the Miscellaneous Working Circles. Here the object will be to regenerate *sal* which is fast disappearing owing to excessive drought and to replace the existing worthless species by more valuable ones.

9. There are at present four *taungya* villages in this division with a total population of about 500 souls. With the expansion of *taungyas*, this population will tend to increase. The arrangements which have been made or are proposed for the comfort of the *taungya* villagers might be found interesting. In the *taungya* village in the Baniawala block where the forest is of dry Siwalik *bhabar* type, water for human consumption and cattle is very scarce. The nearest village well is about 3 miles away and water in the *raus* (water courses coming down from the Siwaliks) dries up lower down in October. A channel has been made to bring water from the upper parts of the nearest *rau* down to the village and this gives water up to February—March. The channel is about 3½ miles long and the cost incurred was only about Rs. 30. The cost is low because all work in the lower portion of the channel was done free of cost by the *taungya* cultivators themselves. From March till the break of monsoon, water is brought in small portable tanks and drums loaded in carts from the nearest village well which is about 3 miles from the *taungyas*. The Forest Department supplies the portable tanks and drums and the rest is done by the *taungya* cultivators. The cost of the portable tanks and drums was about Rs. 150 and these will serve for 3 or 4 years. As the *taungya* expands and moves further northwards, it may be possible after a few years to run a pipe line from the water supply from the upper parts of the *rau* down to the *taungyas*. A well is out of the question in these dry *bhabar* localities.

The *tarai* areas in the Pathri block *taungyas* present a different problem altogether. Abundance of water, unhealthy swamps and

malaria are the chief among the many drawbacks which these areas present. A tube well with hand pump has been installed in the *taungya* village for the supply of good drinking water at a cost of Rs. 45/-. As protection against malaria an adequate supply of medicines has been provided with instructions to the Range staff to have the medicines administered to the patients in their own presence. Arrangement has also been made for the medical officer of the forest dispensary in the adjoining Dehra Dun Forest Division to visit the *taungya* village once a week during the rains.

10. Bumper crops alone which he reaps from the virgin forest soils are not sufficient to attract the cultivator to forest *taungyas*. A sympathetic treatment meted out to him, tact in dealing with his idiosyncrasies, immediate attention to his complaints, and administering to his small needs go a long way to make him contented and happy. He alone can solve the regeneration problems which our forests present. The *taungya* which has been made a practical proposition by these simple hardworking folks seems to be the only solution of perpetuating most of our plains forests in the United Provinces.

EUROPEAN SILVICULTURAL RESEARCH
PART VIII—INCREMENT SAMPLE PLOTS.

By H. G. Champion, I.F.S.

The importance of standardised methods for the collection of crop increment data has long been realised, and the subject appears on the agenda of forest conferences from the beginnings of organised research. Whilst each country has developed a technique for the work on its own lines, the advantages of international co-operation have long been realised. This co-operation could be made effective either by the adoption of a standardised international procedure, or by standardisation separately in each country with a published detailed account of the method followed, such that the results obtained in different countries could be co-ordinated and combined, if desired, after applying necessary correction factors to make them directly

comparable. The latter method has the great advantages of flexibility under varying conditions and avoidance of that check on improvement that stereotyped procedure always involves.

As the outcome of a resolution passed in 1929 by the International Union of Forest Research Organisations at Stockholm, the participating countries are publishing accounts of their procedure and several are now available—Prussia, Bavaria, Sweden, Finland, Austria, Great Britain. No marked innovations appear in these accounts nor indeed would any be expected, but some points of interest were met with during this tour and are reflected in the written codes.

The chief point, and one to which special attention was given owing to difficulties experienced in India, was the question of the measurement of standing sample trees. For those not intimately connected with sample plot work, it may be mentioned that the accuracy of our determination of crop volume and increment from sample plots depends mainly on our success in obtaining truly representative sample trees for detailed measurement. Whilst the thinnings will usually give suitable sample trees for the smaller diameter classes, considerable difficulty is experienced in obtaining samples for the important dominant classes. Although a surrounding strip is maintained partly to meet this requirement, it can only help to a limited extent before the felling of these dominant trees results in its becoming no longer comparable with the sample plot. All research centres have encountered this difficulty, and much work has been going on in devising and testing out alternative methods which can give the required information with the necessary degree of accuracy.

The advantages of taking as samples selected standing trees in the plot itself are numerous and self-evident. The most obvious methods of getting the measurements are to climb the tree for the purpose, or to make use of precision optical instruments from the ground, the theodolite suggesting itself as suitable. The theodolite has in fact been tried in Saxony and elsewhere, and rejected as too slow and laborious, with considerable chances of slips in the field work. The Saxon Research Institute has developed a wonderful instrument based on recent developments of aerial cartography, designated a

"Doppelphotogrammeter" and consisting essentially of 2 cameras on the range-finder principle at the ends of a rigid horizontal bar about 3 feet long. A special "stereocomparator" is necessary for deriving the required measurements from the stereo photos. About the same precision is obtainable as with the theodolite with the advantages of leaving all figuring to be done at convenience in the office, and giving a permanent record capable of check at any time. The objections are obvious—the need of a skilled photographer and a clear view of the tree, and an expenditure of at least Rs. 2,000/- on the instrument—and these features at present rule out the method for India.

The climbing idea is nothing like so simple as it sounds. Climbing irons cannot be used owing to the damage to the tree apart from the difficulty and risk in taking measurements requiring both hands. Ordinary ladders tall enough for the job are too heavy for transport and when set up are too far from the bole for measurements to be taken, and once again there are undesirable risks in using both hands on measurement work high up on a ladder. Ladders of the fire escape type go some way to meet these objections, but the best development is that worked out by Dr. Schmied at Mariabrunn (Vienna) in which a very light sectional ladder is tied to the tree at short intervals all the way up, being kept a little away from the bole by folding struts to make room for the feet. Measurements on the bole would still be very difficult to take from the ladder, so this is not attempted. The ladder serves only to enable a man to get up into the crown where he attaches a pulley arrangement carrying a swinging seat which can be *pulled up and down and from which* the actual measurements are taken. Experience has shown that the work can be done accurately and with reasonable expedition, and the main problem is that of accurate determination of the height of the tree. This difficulty is met by using two ladder parties as a unit for field work so that the man up each tree can direct the other as to the correct height to elevate the light staff carrying the end of the measuring tape. It may be mentioned that most of these methods are under trial at Dehra Dun and will be reported on before long.

In Prussia, trials with these methods were not considered sufficiently promising, and a different line was being followed up by Dr. Wiedemann. The problem is to get acceptable data for tree form factor, to combine with instrumentally determined height, and it would appear that a detailed knowledge of the relations between tree form factor and the taper of the lower accessible part of the bole (form quotient) should permit of the limiting of diameter measurements to those easily obtainable. Actually for conifers it appears that a single measurement at five metres will suffice, and this can be quickly, easily and safely obtained from a simple ladder. For broadleaved species, the individual variations among trees are so large that changes of form over short periods are completely obscured. The practical difficulty in the application of this method is the necessity of extensive data to prove for each species that it is acceptable, and to give the required standard relationships. In view of its simplicity, however, it will obviously be worth trying out as opportunity offers.

In Switzerland, both points of measurement are marked with paint to reduce the chances of error and the small black paint numbers are painted over a red paint rectangle and this seemed to give good results. The numbers are quickly printed on the trees with dies made of a special composition suitable for transferring paint from a pad; this method which has advantages, has also been adopted by Finland.

In the present connection, it is natural that attention has been directed again to instruments for measuring the height of standing trees, and various new instruments have been put on the market, especially by the Baltic countries. A stand is essential to give the precision needed in sample plot work. The need of measuring each tree from more than one view point is generally stressed, and the difficulty of making certain that one is intersecting the actual top and not a projecting branch, is met to some extent in this way and by increasing the number of trees measured. The Finnish workers appear to go furthest in this matter and take enough measurements to permit of the construction of separate height curves for each canopy class (they use Lönnroth's hypsometer). In Bavaria, too, up to 40

standing heights are measured in addition to those on 8 to 10 felled sample trees. Various novel forms of callipers have also been devised to facilitate work.

For certain studies in sample plots it is of interest to determine the crown space occupied by the different tree classes in a crop. Various instruments have been devised to facilitate this work but on the whole it seems that purely optical estimates may give all the precision needed provided the personal factor is kept the same throughout any single investigation. Thus, in Prussia, complete crown maps have been made in over 60 sample plots by pegging out five metre squares and plotting the crown spread of each tree by eye on squared paper. It was found that a half-acre plot in a middle-aged crop took one worker two to three days.

Remeasurement still remains quinquennial in the majority of countries though sometimes more frequent in special investigations. Like ourselves, Prussia now only puts through the whole procedure after 10 years, with a partial measurement after five.

The computing work is variously organised. In Prussia, it is done by junior forest officers and clerks, and a special feature is the computation work done prior to visiting a plot for remeasurement to expedite the field work. The approximate basal area and number of trees to be removed under the prescribed scale of thinning is worked out on standard yield tables and the previous measurements so that the actual marking can be completed in half an hour or so.

In Switzerland, computing work is done by lady secretaries partly with the ordinary rotating calculating machines like those we use and partly on a special electrically operated machine in which division, for instance, is performed entirely mechanically. This instrument costs about Rs. 1,500 and may be worth it to them, but like all such machines, can only be considered as a practical proposition where an expert is available to keep it in working order.

In computation work, two points call for passing mention, *viz.*, the increasing use of basal area in place of diameter as a co-ordinate in curving the various functions, and the tendency to differentiate thinning grades in the preparation of yield tables.

The number of standard plots maintained by the different countries is of interest for the sake of comparison. Prussia has about 900 under the Silviculturist, Saxony 200, Bavaria140 and Switzerland about 300; Great Britain has 183. There are of course many more maintained for special purposes by various research workers. Only in Prussia is the maintenance of the plots virtually a whole time occupation, combined of course with special investigations in them, and in most countries communications are quick enough to permit the chief silvicultural officer to mark all plots personally. In India, we have now 1,425 permanent sample plots distributed over 11 provinces, the maximum number in any one province being 368 in the United Provinces.

It is also interesting to note that the sample plots are frequently not in State forests, but in privately owned forests. This is particularly the case in Great Britain and in Austria.

The directions in which recent European developments may be of use to us in India have been mentioned in the course of the above survey. The most important is unquestionably that of the measurement of standing sample trees. Tests have already been in progress for some time in Dehra Dun and it is hoped that they will soon be advanced enough for publication. Improved mensuration instruments have also been procured from Europe and are under trial in the forest. Our standard procedure was published in our 'Statistical Code' in 1931. Unfortunately our great immediate need, that of a satisfactory technique for the study of growth data for selection type forest, has not been advanced by anything the institutions visited had to show.

SOME BURMA NOTES ON THE PROBLEM OF PURE TEAK PLANTATIONS. (FOREST BULLETIN No. 78).

BY H. R. BLANFORD, I.F.S.

1. *Fluted boles.*—These are especially prevalent in plantations and natural forest south of Toungoo Division in the whole area between the Sittang and Yunzalin rivers comprising the Shwegyin and

the greater part of the Thaton Division (including the former Salween Division). Elsewhere this defect is found occasionally, especially on flat ground but is not usually so marked or so serious as in the area mentioned above. Several theories have been advanced for this defect, among others bad drainage and heavy rainfall, but none of these are in any way conclusive. In plantations in this area, hardly a single stem is free from fluting and many are so badly fluted that they have been likened to a Haig and Haig whisky bottle. It is extremely unlikely that this fluting is in any way caused by epicormic branches. The fluting goes right up the stem and even into the larger branches. It is not confined to any particular soil, aspect or situation. One possible explanation is that it is a local racial defect and that all trees grown from seed from this locality would tend to have this defect. This could only be proved by growing teak in this locality from seed from a locality which produces well shaped trees and *vice versa*, but unfortunately this is only now being attempted and it must be many years before this theory can be tested out. On the assumption that the defect is heritable, a wise precaution in all localities would be to avoid the collection of seed from any trees which are fluted. It has been amply demonstrated in Mr. Champion's recent article on European Silvicultural Research Part III, Inheritance Problems, that the use of badly shaped trees for seed is fraught with danger.

2. *Epicormic shoots.*—In Burma at any rate it seems doubtful if defoliation is a serious cause of epicormic shoots. I believe there are two main causes for epicormic shoots.

(*i*) Overcrowding followed by thinning.

(*ii*) Fire.

(*i*) *Overcrowding followed by thinning.*—Teak is more intolerant of interference with its growth by its own species than by many others. As soon as crowns in a plantation touch, wind causes damage to the buds by their contact with the stiff twigs of the neighbouring trees. Continued crowding leads to a further damage to the buds all round the periphery of the crown and results eventually in a condition where the side shoots in the crown adapt themselves to the crowded conditions

and do not put out vigorous shoots. Exactly the same condition is seen in the case of advance growth of teak growing under heavy cover. The plant adapts itself to the conditions of shade and produces annual shoots which may only be an inch or two long. When light is admitted it is incapable for adapting itself immediately to the altered conditions and for some years continues to put on small and feeble shoots. In the case of the side shoots in a crown which has been growing in a conjested plantation, the same thing happens when a thinning is carried out. The crown is not able to take advantage of the space and light given by the thinning; in other words the tree is "crown bound." At the same time, the extra space and light is a stimulus towards growth and as the tree cannot respond by growth of the crown laterally, the stimulus acts on dormant buds and epicormic shoots result. Early thinning as soon as the canopy closes up allows of a vigorous and healthy growth of the crown and epicormic shoots are rarely found in plantations where the crowns have been allowed to develop normally even where there is little or no undergrowth.

In mixed plantations where the species growing with the teak has lighter twigs in its side branches, such as *pyingado* (*Xylia dolabriformis*), the side shoots of the teak crowns are not checked in the same way and a close canopy of the teak and *pyingado* does not restrict the crowns of the teak to the extent they are restricted in pure teak. The danger in mixed plantations of teak and *pyingado* is that on good soils *pyingado* usually outgrows the teak where it has full room for development. In close stocking such as teak and *pyingado* in quincunx, the canopy of the teak would probably close up before the *pyingado* recovers from its slower start, but in this case all the conditions of a pure teak plantation are produced in the canopy and the early thinning required may still let up the *pyingado* to compete in height growth with the teak at a somewhat later stage. Nevertheless, there are great possibilities in a teak and *pyingado* mixture. *Pyingado* is certainly one of the best species we have for an understorey as it gives a good soil cover and its leaves are probably very beneficial in producing something as near to a humus as we are likely to get.

It coppices well and provides an excellent undergrowth from coppice besides being likely to give marketable timber of small size at maturity even though it may have had to be cut back. Several experiments of teak and *pyingado* in quincunx, teak in wider spaced groups in quincunx in *pyingado*, and teak at wider spacing with the rest planted with *pyingado* are now being tried and should be carefully watched. At the same time, the study of mixed crops in Java has shown that there are no particular advantages and there may be actual disadvantage of intimate mixture and it would be unwise to carry out experiments on any but a small scale.

(*ii*) *Fire.*—I am convinced that this is a frequent cause of epicormic shoots especially in young plantations. The following extract from an inspection note (dated July 1932) on a 1920 teak plantation in North Toungoo Division gives a definite instance of this statement and is perhaps more convincing than a theoretical discussion.

" The plantation was thinned in the hot weather of 1930 for the second time. Epicormic shoots were very numerous. As this has been said to be one of the results of overthinning, the subject is of considerable interest. In this plantation there is a sample plot which was made by the Silviculturist in 1924. For some reason or other, this sample plot has apparently never been thinned since and is therefore, considerably closer in stocking than the rest of the plantation which was thinned in 1930. It is in urgent need of thinnings. Yet even in this sample plot epicormic branches are just as bad as in the rest of the plantation Together with a number of epicormic branches, up to a considerable height on the bole, were a number of small dry branches, which had the appearance of having been killed by fire. A search in the Compartment Register shows that 7 acres of the plantation including the sample plot were burnt in 1924, and there was no expenditure on fire-protection in 1928-29 presumably because early burning was introduced. It is fairly obvious that these dry branches, and epicormic shoots which have replaced them, originated from the fire in 1929. In a 1926 plantation, which had been burnt accidentally in 1930, the same dead branches and the same epicormic shoots replacing them were found, and I have little doubt that the epicormic branches, which are so common a feature of many

of our plantations, especially the younger ones, are often due to burning. Injury of any kind, provided it is not too severe, always leads to an invigorated growth either of callus in the case of wounds, or of shoots in the case of an injured portion in which dormant buds exist. In this particular plantation of 1920 the undergrowth is good and erosion has not been very serious, but the production of epicormic shoots as a result of fire is yet a further argument in favour of wholesale fire-protection of our more concentrated teak plantations."

3. *Defoliation.*—It is mentioned in the Bulletin that, in Burma, cases had been recorded of the death of the leading shoot after defoliation in young plantations. The most serious aspect of this was not mentioned. Defoliation in young plantations, especially late in the season when the growing vigour of the trees is diminishing, leads to serious forking of the tree owing to the death of the leading shoot. Teak with its opposite leaves and buds replaces the leading shoot by a pair of shoots, and unless one of these shoots dies back, as occasionally happens, the result is a fork. It is probably only in the case of defoliation late in the season that there is serious danger in forking owing to the fact that the tree has not sufficient vigour to produce a complete flush of leaves and the sap is used up in producing the flush in the lower part of the tree, so that the leading shoot is starved and dries up. Cases have occurred when a considerable percentage of the crop has produced forks for this reason, and it has a serious result on the value of the crop when the forked trees are so numerous that they cannot be eliminated in thinnings without leaving the crop open and very uneven. In passing it may be remarked that burning is also a frequent cause of forking in young plantations. The leading shoot being the softest and tenderest part of the tree is particularly liable to damage from the heat of a fire and if the leading bud dries up, forking results.

4. *Soil deterioration and erosion.*—I personally have no belief in the soil deterioration as apart from erosion in pure teak plantations. Not a single instance of soil deterioration *per se* has been given which cannot be explained by either lack of a good fire at regeneration or by erosion. The latter is by far the most serious cause of soil deterioration. The degree of erosion varies considerably with the class of

soil, but I have seen case after case where erosion can be definitely attributed to fire. The result of a fire (early or late makes no difference) apart from damaging and reducing the undergrowth, removes the covering of dead leaves and leaves the soil exposed to the heavy drip from the large teak leaves. This breaks up the soil into its finer particles and on even the slightest slopes renders it more liable to be washed away. In the case of fire-protected areas, the thick carpet of leaves breaks the direct drip on the soil and, as the leaves soften and decompose, provides a matted cover which assists in holding the soil particles together. The example quoted in the Bulletin of a plantation in Myitkyina Division can be added to almost indefinitely in almost every unprotected plantation or area in which an accidental fire has occurred.

In this connection, the result of burning in one of the best plantations of just over 20 years that I have seen anywhere, was noted in plantation No. 1 of 1909 in Compartment 12, Myohla, North Toungoo Division. This is a very well stocked, well grown plantation which has not been fire-protected for a number of years; yet the damage from erosion is truly appalling, in many cases roots being laid bare to a depth of at least one foot below the original level of the soil. As a result, along the banks of the stream which runs through the plantation, a number of trees have fallen over. Whether this very serious erosion will tend to cause a falling off in increment in this plantation remains to be seen, but such conditions of soil as were seen here can hardly be healthy for any plantation. To show the extent to which erosion has been proceeding in many places, there were deep gullies eaten out of the ground. Generally, the plantation was somewhat deficient in undergrowth and efforts to introduce an undergrowth of bamboos, *tinwa* and *wapyu*, have not been very successful.

I do not think it would be exaggerating to say that soil erosion in pure teak plantations is entirely due to lack of fire-protection or accidental fires. Admittedly, erosion may be alleviated by the presence of undergrowth, but burning is the main cause of all erosion, primarily by removing the soil covering of leaves and only secondarily by hindering the healthy growth of the undergrowth.

5. *Remedies.*—The notes given above only confirm the general conclusion in the Bulletin that the complaints against pure teak plantations are mainly due to mistakes in past management. Falling off in rate of growth although not proved is quite probable as a result of soil erosion resulting from failure to fire-protect. It is definitely proved to be the result of inadequate thinnings in early years. Fluted boles are quite possibly due to failure to collect seed from the best shaped seed bearers. Epicormic shoots are due to delayed thinnings and failure to fire-protect. Soil deterioration is mainly due to soil erosion which again is due to failure to fire-protect. There remains only the undoubted increase in the incidence of insect pests, and in Burma especially, that most serious pest the beehole borer. Given adequate and early thinnings and fire-protection this seems to be the only real objection to pure teak plantations.

Planting in intimate mixtures or in groups, strips or lines with other species does not seem from the evidence available likely to have very much effect on the incidence of insects, and research in Java tends to show that there are dangers of root competition and loss of quality of timber in such mixed crops. Mr. Scott's recent Burma Forest Bulletin No. 29 shows that rainfall is a far more potent factor in the incidence of the beehole borer than purity of crop, but the limit of 60 in. of rainfall below which the borer is not considered a serious factor, rules out the majority of the best Burma teak forests. It seems doubtful if the problem can be solved in any way by silvicultural means.

Systematic experiments in mixed crops should be continued both with a view to studying the effect on the incidence of insect pests as on the growth of teak in such crops, but there can be no justification at present for making these on a scale larger than is required to show the results in the future or to give up the modern approved methods of planting and maintaining pure teak crops. The principal problem in connection with pure teak plantations remains one for the zoologist and it is to be hoped that this will not be lost sight of in the orgy of retrenchment that is having such an ill-effect on our Forest Research cadre.

COMMENTS UPON FOREST BULLETIN NO. 78.

BY H. G. CHAMPION, I. F. S.

Since the publication of *Forest Bulletin* 78, my attention has been drawn to one or two points in it which can conveniently be referred to in connection with Mr. Blanford's supplementary notes printed above.

(1) In Section 7, it is noted that Madras and Travancore report unimportant beehole borer damage. This statement is in fact correct, but the note should have been transferred to the next section, 'Damage by other insects', as the true beehole borer, *Xyleutes ceramicus*, does not occur as far as is known in either place, and the cause of the damage is most likely *Hyphophassus* or something similar.

(2) In *Burma Forest Bulletin* No. 29, 1932, Mr. Scott has shewn as the result of a laborious and detailed investigation that plantation teak is definitely much more beeholed (14 : 5) than natural forest teak in the same locality, but that this effect is less marked than the variation of beehole with rainfall. With less than 60″ rainfall, the value of timber grown is unlikely to be seriously reduced by beehole.

(3) Mr. De has justifiably commented on the paucity of reference to Assam and in particular to the interesting Kulsi plantation which in part dates from 1872. This plantation was not adequately thinned in its early years and is stated to have a large number of trees with fluted stems. I have recently visited it and did not think that the fluting was exceptional and once again there is no natural forest with which to compare the plantation ; some of the trees are very fine indeed.

(4) It has been represented from the Northern Circle, Bombay, that justice has not been done under Section 15 to the success obtained with the *rab* system. The older regenerated coupes are now *getting their second thinning at 10 years and are reported as showing* excellent results. It should perhaps also have been further stressed that under the prevalent conditions, the *rab* patches are now rarely less than 40′×40′ and 40′×100′ is common. It is believed that the best policy economically and silviculturally is to aim at increasing the proportion of teak in the essentially mixed forest in this way. Many other methods have been tried and found less satisfactory.

The technique has been further improved of late and the method has considerable potentialities under the appropriate conditions. The use of species mixtures referred to under Section 17 has been further developed and is now most favourably reported on in several divisions.

(5) In Nos. 23 and 24 of the publications of the Buitenzorg Forest Research Institute, Dr. H. M. J. Hart has given a very full and profusely illustrated account of investigations into teak problems. No. 23 deals with plantations on very inferior soils and includes a special chapter on underplanting with a considerable number of species. Some of the notes given in Forest Bulletin 78 evidently refer to these experiments which have not given very satisfactory results. The second publication is entitled: "Mixed teak plantations, Part I" and deals with a different series of investigations on good soils, notably those at Margasari, and is the one of which Dr. Hart kindly sent the present writer the translated extracts referred to in the Bulletin. This is likewise a very well produced volume, a most important contribution to the subject, but unfortunately for us, is written entirely in Dutch.

(6) In *Tectona XXV*, December 1932, Dr. F. E. Eidmann published an important paper entitled : "Underplanting in teak," surveying earlier work, particularly the above-mentioned contributions and presenting further material on the subject. A translation of the summary of his paper was reproduced in the May number of the *Indian Forester*. The general conclusion he reaches is that underplanting is useless on bad soils, whilst on good ones, none of the species tried in the earlier experiments fulfils requirements, though recent experience with *Dalbergia latifolia* on good soils is very promising, particularly when the overwood is kept definitely open. This is in marked contrast with the earlier report from Java mentioned in the Bulletin summarising *Dalbergia latifolia* as "totally unsuitable," but the stressing here of the effect of soil quality may supply the explanation. Despite a good deal of disappointment in past experiments, the species appears well worth going on with, and it would be most interesting to see how it does in Burma where it would be an exotic.

EXTRACTS.

QUINQUENNIAL SURVEY OF INVESTIGATIONS ON SPIKE DISEASE OF SANDAL, PART I—LABORATORY RESULTS FOUND APPLICABLE TO SILVICULTURAL CONDITIONS.

BY M. SREENIVASAYA.

1. *Host Plant, the Fundamental centre of interest.*—The sandal plant is influenced by its associated host plants with regard to (*a*) growth, (*b*) seeding, (*c*) heartwood-formation and (*d*) resistance to insect attack and spike disease. Experimental and ecological evidence has been obtained to support the view that at no stage of its life can the sandal plant afford an independent existence with a normal functioning of all the above physiological activities. The associated host plants therefore constitute the fundamental centre of interest, whatever be the line of approach, particularly in a study of the problem of spike disease.

2. *Specificity of Association of Insects in Relation to Specific Host/Sandal Combination Established.*—It is well-known that generally the internal physiological condition of a plant determines its predisposition to disease or insect attack, and this condition in the case of the parasitic sandal has been found to be influenced by its host plants. The variety and quantity of insect fauna infesting a sandal will therefore depend upon the floristic composition of the host group nourishing the plant.

Recent entomological collections of Mr. Chatterjee lend undisputed support to the above statement. The specificity of association of certain species of insect fauna with certain definite host/sandal combinations has thus been established. The practical significance of this discovery is realized if attention is called to the fact that the composition of the sap of sandal could be controlled through a judicious choice of host plants, in such a way as to render it distasteful or repulsive to certain classes of insects and possibly to vectors of disease yet undetermined.

3. *Among Sandal Plants two Types of Immunity Exist.*—Disease transmission studies under controlled conditions have revealed the existence of two types of resistance among sandal plants (*a*) Autogenic resistance exhibited by certain plants, which is largely independent of the nature of the associated host plant, (*b*) Acquired resistance which is built up by the sandal if certain species of hosts and certain conditions of environment are provided. Ecological evidence has also lent support to the existence of both types of sandal plants. Strains of sandal inherently resistant to disease are often encountered in heavily spiked areas, and with regard to the other type of resistance, floristic surveys have shown that the incidence and spread of disease is dependent upon the floristic composition of the area.

The discovery of these factors of disease resistance among sandal plants constitutes an advance of great practical importance, as these facts are helpful in the establishment of sandal forests with resistant stock, reinforced by hosts known to impart immunity to sandal. Two such areas have already been started in North Salem.

4. *High Haustorising Capacity a Guide to Resistant Strains.*—The property of autogenic resistance has been correlated with a high haustorising capacity and a comparatively large root system in the seedling stage of the sandal plant, thus affording a useful and practical guide in the selection of resistant strains. Attempts are now being made to discover a simpler morphological index easily recognisable in the seed itself.

5. *Resistant and Susceptible Hosts.*—Among the host plants through which sandal acquires relative immunity, are *Cassia siamia, Melia indica, Murraya koenigi, Dodonea viscosa, Semicarpus anacardium, Ruta graveolens.* Among the host plants which have been found to render sandal particularly susceptible to disease are *Acacias* in general, *Pongamia glabra, Lantana camara, Cajanus indicus, Caesalpinia coriaria* and *Ocimum sanctum.*

It is obvious that the flora associated with sandal areas could be divided into two groups ; (1) those which impart disease resistance to sandal and (2) those which render it susceptible to disease. This classification can be based either upon (1) direct experimental evidence which is beyond reproach, or (2) indirect evidence based on ecological surveys. The practical knowledge gained through both these sources has been utilised in the opening of regeneration plots in North Salem. Confirmation of the susceptible character of *Pongamia* and *Cajanus indicus* has already been obtained under silvicultural conditions at Jawalagiri.

6. *Artificial Transmission Constitutes an Extreme type of Infection.*—Artificial disease transmission through grafts constitutes an extreme type of infection and a plant resisting this operation would naturally tend to approach a strain possessing perfect and unqualified immunity. In the course of transmission studies, several such types have been obtained and utilised for stocking an area at Jawalagiri.

7. *Resistance to Grafting in relation to Environment.*—Grafts do not always take as indicated above. Organic fusion of the graft with the operated stock is necessary for effective transmission of disease. Sometimes the disease is not manifested in spite of intimate fusion, sometimes the graft is unsuccessful and in yet other instances,

the graft is thrown out by vigorous callus formation. These laboratory findings have been confirmed under silvicultural conditions. At Jawalagiri about 80 per cent. success was obtained with regard to disease transmission through grafts while similar operations at Mahadeswarangudi area, repeated twice, have resulted in a complete failure to induce the disease. The explanation of this remarkable and encouraging phenomenon is to be sought in the strikingly different floristic aspects presented by those two areas.

Grafting under silvicultural conditions affords a useful technique for determining the susceptibility or resistance offered by an environment to disease.

8. *Root system of hcst in relation to disease resistance.*—Among the other factors of environment which predispose sandal to disease, depth and extensiveness of the root system of the associated host plays an important part. Pot culture studies have shown that, with a given sandal-host combination, age for age growing in bigger pots exhibit greater resistances to disease than those in smaller ones. The greater the volume of soil commanded by the root system, the greater will be the nutrition made available to the parasitic sandal.

The root system of the host plant which is parasitised by sandal may be looked upon as an extension of the root system of sandal itself. Deep rooted hosts, in general, are beneficial to the parasite, not only with regard to its growth but also in building up immunity to spike. The soil profile studies which have been made in this connection, have revealed that spike areas are characterised by a poor root system both as regards depth and intensity. In the choice of host plants for sandal, preference should be given to those species which possess deep and extensive root systems.

9. *Sandal itself a powerful denuding agent.*—In this connection, the effect of sandal in restricting the regeneration of the root system of the host plant, has to be considered. This effect becomes pronounced when the parasitism on the host is heavy. In other words, the importance of recognising sandal as a powerful denuding agent is emphasized. Observations show that the primary attacks of spike have always occurred in places where the sandal stock is thickest and where the major hosts are either dead or dying. Over-parasitism should strictly be avoided in the silviculture of sandal. Regeneration of the parasite should be controlled and a judicious thinning of sandal, having regard to the availability of host plants, should be worked upon as a recognised silvicultural practice. Other plant parasites in the area should systematically be eliminated since their presence would tax the nutritional resources of the environment.

10. *Parasitised hosts do not coppice.*—Pot culture studies have shown that sandal plants, when deprived of their host plants, succumb to the disease quicker. Host plants, parasitized by sandal on coppicing, rarely, if ever, put forth shoots. Field observations at Mognoor and Thalli, point to the same conclusion.

These observations have a pertinent bearing on the silviculture of sandal. No exploitation involving the deprival or weakening of host plants should be encouraged in sandal bearing areas. All the host resources of the area should be conserved and consolidated for the vigorous and healthy growth of the parasitic sandal.

11. Experimental transmissions have shown that a sandal plant kept continuously under shade is more susceptible to disease than a corresponding one kept exposed to the sun. The "shade" plants take on grafts with a higher percentage of success and succumb to the disease in greater numbers. This lends experimental support to the observations of Rao Bahadur K. R. Venkataraman Ayyar who has always held that plants "under suppression" are predisposed if not actually infected. On exposure to the sun, these plants manifest the disease symptoms; and the "shade" plants grafted with disease tissue behave in essentially the same manner with the bursting of new buds in response to the stimulus of sunshine. "Suppression" or "shading" of young sandal should therefore be strictly avoided in the silviculture of sandal.

12. *Masking of disease.*—In the course of transmission studies, it has been found that some sandal plants mask the symptoms of disease for long periods. In such cases, defoliation of the plant has been found successful in forcing out the symptoms of spike. The plant, during the period of "mask" puts on girth and height.

Under silvicultural conditions also, this phenomenon of masking has been observed. In every infected area dozens of such plants may be found; in Manchi, for example, about twenty per cent. of the stock in the area were found to have been already infected. This technique of pollarding has been found extremely useful in forcing out the latent symptoms of disease and in ascertaining whether an apparently healthy tree is free from infection or not.

13. *Pollarding an important technique to force out symptoms.*—Sandal plants which thus mask the symptoms, constitute treacherous sources of infection, since it has been shown, by experiment, that the disease can be transmitted to other healthy sandal plants by grafting some of their tissues. Eradication of spike would not therefore be complete unless such sandal plants masking the disease are also eliminated. Non-removal of such apparently healthy sandal plants has been mainly responsible for the successive recrudescences of disease in an area often in epidemic proportions. In any scheme of eradication of spike therefore, it is essential that pollarding should be adopted as a means of detecting "masking" trees. In dealing with Manchi and Caligatam spike areas, this useful technique has been put into operation.

14. *Disease is localised and opportune ringing prevents further spread.*—Laboratory experiments have shown that the disease is localised in the initial stages of infection and that the transport of the causal entity to other parts of the plant from the site of infection is slow. Ringing at the right place will prevent the spread of disease to other organs of the plant and save the tree from spiking. The practical application of this interesting information in the control of spike disease is limited by the fact that under silvicultural conditions one does not know the site of infection. During the operation of pollarding, however, it is possible that decapitation of branches involved may lead to elimination of infective organs and save the rest of the plant.

15. *Season of Infection.*—It has been definitely ascertained that the season in which the actual infection occurs is during the months of April and May which corresponds with the period during which scars and other injuries are intensively inflicted on the sandal plant through some agency yet undetermined.

16. *Season of external manifestation of symptoms.*—The symptoms of spike tend to manifest themselves on infected sandal plants during the season which corresponds with the vegetating period of sandal. During April, May and June, under the stimuli of moist-heat and sunshine, the disease manifests itself with the growth of the new flush from the dormant buds. This information is very useful in fixing the season during which a vigilant watch has to be kept over sandal-bearing areas when fresh attacks may be expected in large numbers.

17. *Shift of the season.*—A shift in the season of maximum disease incidence may occur due to natural causes, which result in forcing out new flush in sandal plants. Forest fires and browsing by herds are the two causes which effectively alter the period. The season during which fires occur or the "fire season" is known to forest officers and soon after its occurrence the epidemic should be looked for.

18. *Primary attacks associated with denuded spots.*—Primary site of attack, so far as our present observations indicate, are characterised by marked changes in floristic composition, the change always accounting for a degradation towards the scrub xerophytic type of vegetation. Deep rooted species are replaced by shallow rooted and deciduous shrubs of the *Lantana* type, rendering moisture and nutrients from deeper layers unavailable to sandal. This degradation is often found to be the combined result of exploitation, fire, overparasitism, grazing and other denuding factors. Effective measures for the protection of our sandal areas from the attack of these denuding agents should be laid down and rigidly enforced.

19. *Lantana and spike.*—The frequent association of *Lantana* with spike trees has led us to believe that it has some relation with spike disease. Laboratory experiments have shown that *Lantana* is one of the plants which renders sandal susceptible to disease. The more serious aspect of *Lantana* is its aggressive spread with the gradual elimination of all useful species in the area. Its growth renders the soil toxic to most other plants, which die in course of time. The ease with which *Lantana* catches fire during the hot weather renders it a dangerous source of combustible material, and consequently the cause of frequent fires which accelerate the denudation of the area. Bird life becomes scarce in *Lantana* areas which proportionately encourages an abundance of insect fauna and possibly an increase in the concentration of the vectors of spike disease. Elimination of *Lantana* is a problem of great importance not only in respect of spike disease but also from the viewpoint of general silviculture.

20. *Elimination of Lantana effects remarkable ecological changes.*—It has been observed that artificial suppression of *Lantana* has a marked influence on reducing the incidence of disease, as found in Cairn No. 53, Observation area. This fact is due to the circumstance that continual weeding out of *Lantana* has enabled beneficial species to come up and the ecological change effected in the area during the last seven years is remarkable. The surveys have revealed that out of the 57 species of plants occurring in the *Lantana* free area 21 are exclusive to the plot and are entirely absent from the *Lantana*-infested area ; with regard to the other species occurring in both plots, they decidedly preponderate in the *Lantana*-free area, where one cannot fail

to notice that the plot has been well stocked not only with sandal but also host trees. This is a striking instance where, through human effort, a restoration of the deciduous high forest type of vegetation has been effected through the simple operation of weeding out *Lantana* and the practical bearing of this fact on the control of spike disease is quite obvious.

21. *Haustorial spread of disease not a serious factor.*—The percentage of effective artificial transmissions through haustoria so far achieved does not exceed 8, and therefore under silvicultural conditions the spread of disease through roots is possibly very small. The secondary spread of disease is in consequence largely effected above ground, through some agency yet under investigation. In the practical control of disease therefore, factors operating above ground demand relatively a more serious consideration.

22. *Arsenical preparations to combat spike.*—Effective removal of the sources of infection should be the immediate objective so far as diseased areas are concerned. Application of Atlas and other arsenical preparations has been found to be a most effective agency in rendering the causal entity in the entire plant innocuous. The arsenic does not appear to interfere with the valued essential oil in the heartwood.

23. *Scars, measure of disease incidence.*—In absence of any statistical information regarding the relative abundance of insect fauna in the various observation areas, a study of the scars has been helpful in obtaining a comparative idea of their existence or activity with respect to sandal. Results indicate that the intensity of attack on sandal as measured by scars is roughly proportional to disease incidence.

SANDAL INSECT INCIDENCE WITH REFERENCE TO MR. SREENIVASAYA'S PAPER.

Statistical information is now available regarding the relative abundance of insects in some of the observation areas referred to by Mr. Sreenivasaya in his last paragraph (23). Surveys were made in sample plots 14 (Cairn 53, Jawalagiri), 20 (Nymasundiram Agraharam), and 21 (Mahadeshwarangudi). Of the total number of sucking insects collected during the course of a year about one-third occurred in plot 20, a little more than a third in 14 and somewhat less than a third in 21. Jassids were equally abundant in all three plots (about three-tenths of the hemipterous population of each plot). Fulgorids were as abundant as jassids in plot 14, but only three-fifths as abundant in plots 20 and 21.

Plot 21 in Mahadeshwarangudi is a resistant area (*vide* Sreenivasaya, ante para. 7), hence the presence or absence of a vector is a factor of smaller importance in the spread of the disease. Comparison of the incidence of suspected vectors can therefore be restricted to plots 14 and 20.

The jassids of sandal comprise 36 species of which five are dominant. The most abundant scar-making species are *Acropona walkeri* (equally numerous in both areas), *Petalocephala nigrilinea* (1½ times as numerous in 20 as in 14), *Moonia albimaculata* (1½ times as numerous in 14 as in 20); *Bythoscopus indicus* and *Ledra mutica* are relatively much less abundant but more numerous in 20 than in 14. Together these scar-making species form a quarter of the hemipterous population in each plot.

Two dominant species of fulgorids occur, *Sarima nigroclypeata* and *Eurybrachys tomentosa*, which both are a little more abundant in 14 than in 20. These do not make scars.

In view of Mr. Sreenivasaya's finding in paragraph 23 that the intensity of attack on sandal as measured by scars is roughly proportional to the disease incidence, it is interesting to note that the total incidence of spike in the areas of plots 14 and 20 over the last six years was practically the same (36 to 37 per cent.).

Mr. Sreenivasaya (para. 2) draws attention to the effect that the host-group nourishing sandal has on the variety and quantity of the insects occurring on sandal, and suggests that a judicious choice of host-plants might render the sandal distasteful or repulsive to certain classes of insects. A study of the data of the group surveys (to which reference has been made in the Quarterly Reports on the Investigations on the Spike Disease of Sandal, V. pp. 13, 14 and VI pp. 16, 17) shows that the abundance of some species of sucking and biting insects could be influenced through the host-plant, but reduction would probably not go as far as elimination. Taking the ten commonest jassids and fulgorids and the three commonest weevils we find that in all sandal-host-combinations except one, *Acropona walkeri* is the most abundant insect on sandal, but in the *Pterolobium*—sandal association it is the fourth species, dominated by *Myllocerus*, *Moonia* and *Sarima*; and in all combinations but one, *Moonia* is the second most numerous species, being outnumbered by *Sarima* on *Zizyphus*—sandal.

The host thus does not eliminate a true sandal insect. But from the aspect of numerical abundance we find these ten jassids and fulgorids are far more numerous on sandal in the *Erythroxylon* combination than in the others, owing to the fact that they are equally numerous on this alternate foodplant; they are least abundant (about 30 per cent.) on sandal in the *Zizyphus* combination and still scarcer on this host. The weevils are dominant in the *Pterolobium* combination, but are not entirely absent from the other combinations though rare.

Incidentally it may be noted that the relative incidence of the jassids and fulgorid species when estimated by sandal-host groups differs from their relative abundance in the area as a whole. The order of abundance in North Salem is *Sarima*, *Petalocephala*, *Acropona*, *Moonia*, *Bythoscopus*, *Eurybrachys*, *Ledra*, etc.

With regard to *Lantana* Mr. Sreenivasaya (para. 19) expresses the opinion (also held by many) that a general increase of the insect population and a possible concentration of vectors may occur as a result of the purity of the flora and other factors, such as scarcity of birds. Actually the insect fauna of *Lantana* is very impoverished and were it not for the numerous polyphagous species that eat *Lantana* as readily as anything else *Lantana* areas would be almost barren. In the host group enumerations many of the "sandal" insects are entirely absent from *Lantana* and the numerical level of the population on sandal associated with *Lantana* is very low; in fact there is only one other combination in which the population of sandal insects is lower and that is *Zizyphus*. Over thirty species of insectivorous birds have been observed to frequent *Lantana* areas in spite of the shortage of food.

C. F. C. BEESON.
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THE PROPER USE OF LAND.

Much has recently been written in other countries on the need for a more intelligent utilisation of land. In the older countries such as Britain intensive regional surveys are disclosing a lamentable lack of co-ordination in the uses to which the land is being put. Where the community is definitely an agricultural one the farmers can frequently be trusted to find out what crops grow best but the decisive factor is so often the available market that the farmer is forced to grow crops less suitable for the land in question. The haphazard way in which sugar factories are springing up all over northern India is a good example of lack of such co-ordination, for factories dumped down too close together may prove just as harmful to the farmer's interests in the long run as a complete lack of them must be to the sugar grower.

The larger view which we wish to emphasise is not in the choice of one or other agricultural crop, however, but in the need for a sane and efficient planning of land uses according to the intrinsic value of the land for any given purpose, be it agricultural crops, dairy farming, town planning, industrial development, timber production, water conservation, public recreation, or some other definite contribution to the common welfare of the community in its widest sense. The need for intensive soil surveys was considered by the Royal Commission on Agriculture in India but on the score of expense the Commission decided that a soil survey for the whole of India was not feasible. What we wish to recommend is not so much elaborate soil analyses as a reasoned system of regional planning of land uses.

In our American contemporary, the *Journal of Forestry*, several recent numbers have had interesting contributions on this subject

and we have recently received a pamphlet, *Land Use Symposium*, published by the American Association for the Advancement of Science, which contains a summary of the various viewpoints,—agricultural, forest, water conservation, town planning, etc.,—each written by a recognised authority in these lines. In the rapid agricultural development of a partially developed country such as the United States, much ground which was really quite unsuitable for the purpose was cleared for agricultural crops, and after a varying period of years of fighting against nature these farms have become deserted. The total of such derelict land in the United States amounts to the astounding figure of 100 million acres. This is made up partly out of land which is obviously unsuited for agriculture and which should never have been disforested, partly from land which was originally fit for cereal crops but which through bad farming practices has deteriorated with sheet erosion and is no longer fit for agricultural use. It is largely to improve the use of such derelict land that the New York State has recently voted the spending of 19 million dollars in the next decade for a plan to acquire and afforest one million acres. This is the largest and most constructive forestry plan yet adopted by any single American State, although the present Federal Government is spending some 3 million dollars annually on forestry and a further 8 million dollars on forest road making. The newly appointed President of the United States is fully alive to the benefits of forestry and is reported to be preparing a federal afforestation scheme which will give employment to 250,000 men. The money to be spent in this way is to be saved *by curtailing Government expenditure in other directions.*

Such figures should be interesting to Indian economists and politicians alike in view of the present Government of India policy of placing the entire responsibility for a constructive forest policy upon the provincial Governments. The closing of the Dehra Dun Forest Rangers' School in October 1933 may appear to be a small item to many people, but it raises a doubt whether those in authority have grasped the essential facts of forest policy. If the Central Government is not going to help the provinces to provide a training for forest

rangers, a matter beyond the capacity of any single province working alone, it is possible that it may also overlook the larger problems of a constructive federal forest policy. In all other countries with a federal form of government, the central legislature either carries out its own forest policy or insists upon each province and state in the federation doing its bit towards the proper conservation and development of its forest land. India needs a nation-wide programme to prevent misuse or unbalanced development of the existing forest resources in the different parts of the country. In addition to these American figures let us quote from elsewhere. The British Forestry Commission have spent some 12 million sterling in acquiring a total of 627,000 acres by lease, feu, or purchase and have put 63,000 acres of this under plantations since they started operations in 1919. The South African Government have now got 237,000 acres of afforestation and drift sand reclamation, a considerable part of which is on non-forest land which has been purchased. In New Zealand the total area of State plantations is now 348,000 acres with an addition each year of another 40,000 acres, while the activities of the commercial afforestation companies, public bodies such as municipalities, and private owners, mostly farmers, have established a further 340,000 acres of plantations within the last few years. Japan has a planting programme of about 250,000 acres annually. Such figures are naturally comparable only on a basis of existing forest land, and most of the countries mentioned, except the United States, have only a small percentage of their land surface under forest and are in pressing need of larger forests to reduce their dependence upon foreign timber. India for all her vaunted wealth of forests continues to import timber, and manufactured forest produce, such as tea boxes and paper pulp, of vastly greater value than her corresponding exports, so we must regard with grave suspicion any further disforestation of existing reserves. During the last decade the total forest area for some of the provinces has decreased appreciably (*e.g.*, 1,409,000 acres less in U.P. and 854,000 acres less in Punjab) and when viewed in conjunction with the decreased capacity for producing timber caused by overgrazing and consequent erosion in many of our still existing reserves, the position is definitely unsatis-

factory. As an example of the ill-effects of forest destruction we have our eastern neighbour China where wholesale disforestation during the last century has led to inevitable erosion and hundreds of thousands of square miles of what were once forest uplands and profitable grazing grounds are now an irretrievable desert of bare rock and stony scree. The conservation of soil fertility ought to form an integral part of every country's land policy.

On the other hand we have to remember that in many parts of India the Forest Department had a 50 years' start ahead of the Agricultural Department and that consequently large areas of undeveloped land were handed over to the Forest Department as being the only agency likely to make any use of them. A reclassification of such land is now being undertaken in some States and Provinces, such as Travancore and Central Provinces, but the issue is apparently confined to reclassifying scrub jungle under grazing ground or timber forest, thus narrowing the issue to finding fresh grazing grounds for surplus village cattle.

In a recent editorial we quoted figures to show the very large discrepancies which exist in the various provinces' percentage of land under forest. If the forestry question is dealt with piecemeal by each province, we shall almost certainly find that those with large forest possessions will go in for extensive disforestation without any consideration for the requirements of other adjoining communities. The economic utilisation of land requires a very wide view in which the uses of forestry as opposed to other means of development are given the fullest consideration. Gradual alterations in an area from agricultural to denser industrial conditions, or from desert *rakh* jungle to irrigated canal colonies should be closely followed so that the requirements of the new population in fuel and timber as well as in food and water are as fully as possible provided for. An example of how the forestry end of such utilisation can be neglected in spite of statistics to prove the contrary can be seen in the Sutlej canals, where the 30,000 acres allotted for irrigated forest plantations are so badly situated for command of water that it is doubtful if an appreciable amount of this area can ever be afforested in the way that was intended.

It is not generally realised what a very large labour force is supported by forest work, both directly in the forest staff and forest village labour, and indirectly in the great variety of industries dependent upon wood and other forest produce. In actually providing employment, forests have a very definite place in the well-being of the community, and the present development of *taungya* cultivation in so many different forest divisions throughout India should prove a very welcome contribution towards meeting the cultivators' needs. Part-time employment on forestry work is an obvious line of attack in solving the problems of the Indian cultivators' slack seasons and ill-paying field crops, and in these days of over-production of so many of the agricultural crops it would be an advantage to invest some of the nation's money in the growing of timber crops, the harvesting of which can be delayed until better markets and fuller opportunities for utilisation of forest produce have developed. Forest crops are safer than annual cereal crops in times of unmarketable surplus production for this reason.

One should not however advocate timber growing to the exclusion of everything else, for in a country such as India with practically no informed public opinion about forestry we as technical specialists should endeavour to put forward the other advantages of forestry as well, and should emphasise the importance of water conservation and the safeguarding of water sheds. Further, there is the question of the protection of wild life, which in most countries is under a separate department or organisation, but which in India is a somewhat neglected stepchild of the Forest Department. A sufficiency of timber is thus not by any means the only consideration in maintaining land under forest, although it is in the growing of timber that our scientific training finds its main justification. The ideal allocation of land for the community's needs must naturally vary greatly with the standard of living and the stage of industrial development. Taking the figures generally accepted for the United States we find the average requirements per head of population are :—

2·5 acres of agricultural crops,
3·0 ,, humid pasture,
4·0 ,, forest.

On the basis of the recently published census reports for the various States and Provinces, an analysis will show that only in a few of the more densely forested areas does India approach this American standard either in grazing or forest land. To work towards this ideal distribution, the United States are now carrying out very detailed district surveys of land uses, not only to find out the present position, but further to work out a suitable scheme for local development, in fact the application of our forest working plan idea to the countryside as a whole including agricultural and waste lands. In view of the present slump in timber values one might expect forests to be given short shrift in that progressive country, but instead we find a very general realisation that the so-called " border lands " would be better under forest than producing mediocre agricultural crops. More and more it is being realised as one result of such intensive planning that the community's needs in agriculture, forestry and industry are really complementary and not competitive.

EUROPEAN SILVICULTURAL RESEARCH.

PART 9.—THE USE OF STATISTICAL METHODS.

BY H. G. CHAMPION.

In the course of the preceding articles surveying the position of silvicultural research in Europe, frequent reference has been made to the statistical analysis of experimental results, and to the adoption of special methods in laying out experiments such that the data collected would lend themselves to some determination of the errors involved. It would be out of place here to describe these methods, but reference is invited to section XVII of the *Silvicultural Experimental Manual.*

The subject is one which demands very careful attention from all responsible for conducting or guiding experimental research, perhaps even more particularly for those who like foresters are concerned with biological problems. There is an undoubted tendency to look askance at those who would express in figures with unfamiliar signs and symbols, the results of an experiment made to compare, say, two planting methods, instead of merely stating which method had proved

best, and roughly by what amount or percentage. This attitude is largely due to ignorance of what is at stake and partly perhaps to faulty presentation.

In the past, foresters when carrying out experiments have, like their confreres in many another field, altogether failed to realise the complexity of the task to which they have laid their hand. They have hardly ever stopped to ask themselves how nearly they would get the same result if they repeated an experiment two or more times even under conditions apparently identical with those of the first trial. A pair of plots differently treated, however viewed or measured, are practically certain to be different, and till recently this difference has been ascribed without hesitation to the difference in treatment, without bothering at all about the nature and extent of the difference which would have been found had the same treatment been applied to both plots.

In view of the circumstances, it is not unnatural that agriculture should have given forestry the lead in improving experimental technique to eliminate as far as possible this disturbing uncertainty, but it should be remembered that the development is one common to the whole field of biological investigation so that foresters can no longer afford to ignore it. The essential is that every experimental result should be supplemented by some estimate of the experimental errors involved, some indication of the probabilities of the result being ascribable to mere chance.

Forest problems very commonly present special difficulties in comparison with agricultural and zoological ones, mainly connected with the slow development and large size of the material dealt with, and this fact necessitates the development of a modified technique to meet these difficulties as far as possible. In a general way, forestry is forced to be content with a lower standard from the mathematical point of view, and to exercise more judgment as to the most likely course of development, since in practice a narrow selection among possibilities is unescapable and it is necessary to make shift with small samples and very few repetitions, in order to keep experiments to a scale which can be contemplated as a practical proposition.

The fault of presentation referred to is that of forgetting that the figures and figuring are only the means to an end. They serve two purposes, one to enable the investigator to know what conclusions he is justified in drawing, and the other to enable other workers to check the conclusions drawn and sometimes to combine or compare the data with other data.

Neither of these purposes greatly affects the forest executive staff which is only concerned with the general conclusions and can accept the expert's assurance that they are well-founded. So in presenting results for general perusal and use, the conclusions should catch the eye, and the mathematics, necessary though they have nowadays become, should be kept out of the way and not allowed to encumber or obscure the main issue.

With this lengthy introduction, it may be seen what is being done about it in Europe. On the continent, the writer was surprised at the *general apathy of forest research stations towards this modern development*—if not ignorance of it—with the notable exception of the Saxon Research Institute. Among the Tharandt staff, Dr. Busse has been a pioneer in the matter, having already made an interesting contribution to the subject as long ago as 1912, and he and Dr. Münch may now be considered to be the leading continental exponents in this field.

Certainly the most interesting example of the application of statistical analysis to a forest investigation is that described in the third article of this series, concerning the seed origin investigation with *Pinus sylvestris* at Tharandt. This experiment suffers from obvious limitations for the reason mentioned above that it was not a practical proposition to have a number of plots of each origin—in fact there is only one plot of each—but even so, the statistical analysis has made it possible to learn a great deal more than was possible with the older methods, and has also brought out the limitations of any conclusions based on the differences between the plots. Some of the more recent investigations have made use of a method which is very generally a practicable one for getting over the impossibility of making the desirable replication of experiments, namely the use of the routine

work going on in the forest round the experimental plot as a standard for comparison. Thus supposing the relative merits of different planting methods, or different seed origins, are under study, if it is impracticable to have several plots of each suitably arranged, as one would like, each method or origin can be compared with an adjoining plot of the standard local method or local origin, either $\frac{\text{AAAAA}}{\text{BCDEF}}$ or abacad ......and differences from the latter compared, instead of differences between often widely separated plots.

Dr. Busse's replicated thinning plots in spruce for determination of optimum thinning cycle have also already been mentioned. The chessboard Latin square lay-out was not possible here owing to the shape of the area and the nature of the crop, so the serial ABCABCABC arrangement had to be followed. Statistical analysis of the initial data was done to demonstrate initial comparability, and having three plots for each treatment, it is now possible to compare the experimental error with the differences between treatments.

In Great Britain, the Forestry Commission's research staff have gone in whole-heartedly for the replicated plot arrangement of experiments, and though the work is not yet of long standing, they have far more to show in this connection than any other country visited. Procedure in nursery investigations is straightforward and approximates so closely to agricultural conditions as to require no further comment; numerous examples of Latin squares and randomised blocks were seen at Oxford and elsewhere, and methods and some results have been published in *For. Com. Bull.* 11. Artificial regeneration problems have been dealt with on the same lines at all the important centres, quite a large number being now maintained with Latin squares up to 5×5, and randomised blocks from the minimum case of three treatments twice repeated, up to big experiments such as Allerston Ex. 6, P. 28, on species mixtures and effect of nurse crops, on three species, with four replications, making 48 plots in all, with the further complications that some lines in each were manured, and more than one kind of nurse was used in each plot. Soil treatment and species are also the subject of an elaborately laid out experiment, Ex. 1, P. 28, at Allerston, Yorkshire, where there are six variations of soil treatment, each repeated three

times, and five species each three times, or 270 plots. It is inevitable that in the last quoted example the number of plants per plot has become small— 45 only—and the query arises as to whether this does not result in a reduction instead of an increase in accuracy. It might also be objected that such complication is unduly cumbersome, may lead to mistakes, and hinders ocular inspection, but it may fairly be countered that special care is only needed when the experiment is actually laid out—when it can usually be given—and that the computations can be done at any convenient time at the office table, field work remaining the same whether few plants in many plots or many plants in few plots be measured. It is certainly true that the tendency at Rothamstead is towards complicated lay-outs of this type, difficult to follow on the ground. A more real objection believed to be fatal in most cases, is the common impossibility of finding an area sufficiently large to take so many adjoining plots, which can be accepted as uniform enough to permit of the combination of plots for the appropriate computations of error, etc. (The example Allerston Ex. 1, P. 28, quoted is probably one of the rare exceptions, being unusually uniform). Interesting practical limitations of the application of these methods were met with. In the example just quoted, the soil preparations were mainly various methods of tractor ploughing which could not be fully randomised—they were repeated in strips randomised in three replications, ABCDEF, BDFACE, CAFEDB, whilst the five species were repeated each three times in randomised order down the strips, 12345, 21435, 45132. With the lay-out A B B A A B—as an improvement on AB AB AB—, conditions may occur with few repetitions where there is a loss instead of a gain (*e.g.*, Ex. 14, P. 27). Frequently conditions do not really allow of a rigid arrangement of rectangular blocks, and it appears wrong to make it, as has often been done : in forest practice, common sense should be used to exclude unsuitable corners and strips regardless of minor variations in size and outline of plots (Ex. 6, P. 27, and Ex. 13, P. 28, N. Tyne). It is considered this ought sometimes to be done later when assessing results (Ex. 5, P. 27). Not rarely cases are met with where the simple replication of lines or narrow strips in randomised order is much more acceptable

than any lay-out in compact blocks, *e.g.*, species or planting method in an irregular strip of wet ground : obviously an adequate number of replications is necessary.

A common feature in these experiments has been the superposition on the general plan of a factor, such an application of manure, to half of every ultimate plot, or to an equal number of plants for every treatment. There appears no theoretical objection to this, and in some cases (where manure proves essential to development) may prevent the experiment from proving a total failure, but on general grounds it is to be deprecated as infringing the sound principle of avoiding all unnecessary complications : the information should be collected beforehand as to whether manure is necessary or not and then application should be universal or nil.

The thinning experiment at Bowmont Castle with a 4 × 4 Latin square is particularly noteworthy in the present connection, and it is believed that some similar sets have since been laid out in the extensive conifer plantations of the southern Colonies.

In conclusion, it is necessary to make it clear that whilst there is no longer any question as to the value and importance of profiting from these modern developments in the application of mathematical science to biological experiment, the subject is still far from exhaustively investigated, and general agreement has yet to be reached on many points of method and interpretation. The main complications in forestry are the relative smallness of our samples and the exceptional heterogeneity of our material, in turn traceable to the large space occupied by trees. The examples quoted go to show that it is sometimes possible to find forest areas sufficiently uniform and extensive for the application of the Latin square or randomised block layout with up to about 25 plots of acceptable size,—but it is decidedly exceptional. The writer is of opinion that randomised replications in series, with preliminary analysis for exclusion of unduly wide deviations from the mean and the analysis for the significance of means, is the most promising line for Indian forestry. Such methods will, however, remain restricted to a limited number of investigations, mainly to

those dealing with artificial regeneration, and for the rest we shall have to rely on repetitions of pairs or sets of plots laid out wherever we can find a suitable opportunity. The individual research officer can do but little in the huge field of forestry, and the big opportunity lies with the D. F. O. whose operations have to be done on a big scale annually whether they are well founded or not—but the D. F. O. has other things to do. It becomes apparent that progress must come from co-operation between the two, the research officer cutting out of his projects all the trimmings he possibly can, so as to produce proposals acceptable as practicable by the D. F. O., who in turn should move with the times, realising that organised research is essential to progress, and that success to the research worker means service rendered to 'practical' forestry.

KATHA INDUSTRY IN THE CENTRAL PROVINCES.

By Tara Singh, I. F. S.

General.—Acacia catechu (*khair*) provides a local industry in several divisions of the Central Provinces where *katha* is manufactured from the heartwood of this species generally by local contractors who organize small camps in suitable localities and employ some trained labour consisting of several *Khairwari* families.

The work is carried out, as a rule, in the winter season at temporary *katha* camps which are shifted about according to the supply of *khair* available in the locality, for *A. catechu* occurs only scattered in the forests of the Central Provinces.

Trees of 1½ to 2½ feet g. b. h. are generally felled; girths of 3 feet and over are not much cared for, but logs of about 1½ to 2 feet girth are preferred, as they are easy to handle. *Khair* possessing whitish streaks (easily visible when blazed) in the heartwood is credited with yielding the best *katha* both in quality and quantity.

Contracts and Terms.—The dues to the department are ordinarily paid on the number of *hundis* (earthen pots of a defined size) of *katha* extracted by the contractor. The work of *katha* manufacture in the

Fig. 1.—Chipping block and bamboo fencing to collect flying chips.

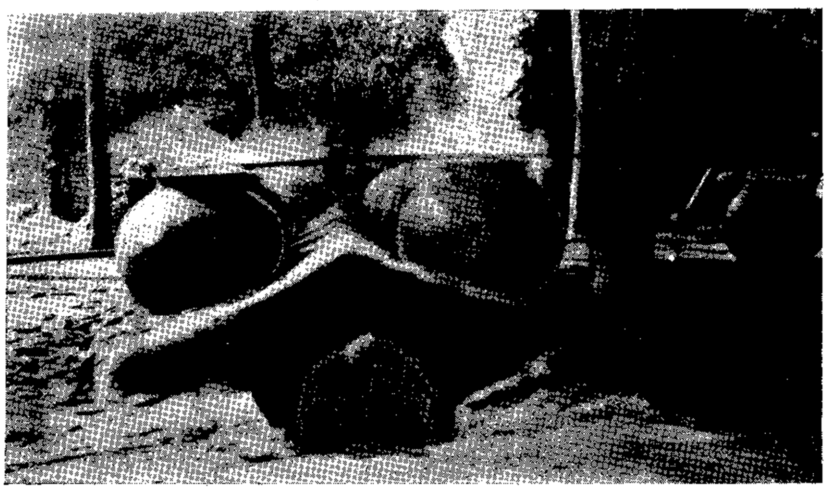

Fig. 2.—Furnace carrying double row of *hundis* or earthenware pots.

Fig. 3.—Pit for separating *Katha* liquid: *Katha* cakes drying on floor of slaked lime.

East and West Pench Ranges of the Nagpur-Wardha Division has in recent years been carried out by the Indian Katha Manufacturing Company of Calcutta. The payment on *hundis* (pots) has in this case been stopped and the contractor is required to pay on the number of *chullas* (hearths) found on each working *bhuthhi* (furnace).

The contract in the first place is given out on a minimum of 50 *chullas* (in this case erroneously synonymous of *hundis*) per month: any increase or decrease in the number of *hundis* once allotted must be intimated to the Divisional Forest Officer 15 days and 3 months in advance respectively. The charges fixed have varied from Rs. 1/12/- to Rs. 2/- per hearth (*hundi*) per month according to the discretion of the Divisional Forest Officer.

Departmental Supervision.—The Range Assistant visits the *katha* camp fortnightly and the Range Officer inspects it monthly: they verify the number of live hearths and check the periodical Returns submitted by the contractor.

Katha Camp and Preliminary Working.—*Katha* is manufactured by a rough and ready method which is probably the same all over the country. A temporary village-camp is established in a suitable locality and *khair* logs are prepared in 10 to 12 feet lengths which are then cleared of all the bark and sapwood. The hewed *khair* log is placed on a thick wooden block, generally made of a cross section of any big tree, and is rested on the forked wooden posts at such an angle as to allow its automatic sliding when the chipping, carried out with the help of a sharp axe, is in progress. The chips are cut as small as possible and are automatically collected in front of the two *tattas* (bamboo fencing) placed 4-5 feet away from the block at an acute angle, standing 6-7 feet high (Figure 1).

Process of Manufacture.—The chips so obtained from the heartwood of *khair* are placed in a *hundi* and boiled with water over an open fire for a long time (Figure 2). The liquid is then carefully poured out into another *hundi* to carry out further concentration. The chips are again boiled with a supply of fresh water and the process repeated in all, 2 to 3 and occasionally 4 repeated boilings are carried out in

order to effect thorough leaching. After the last boiling, the chips are dried and burnt in the furnace. The liquid as obtained above is boiled to the desired concentration over a slow fire. It is then poured out on a cloth, spread on the floor of a small 2′ × 3′ sink full of cold water, for cooling and setting in shade while fully exposed to the atmosphere. Cold water is frequently applied for washing off the liquid in the sink : a large quantity of cutch and a fair amount of catechin (*katha*) are thus drained off and are collected in an adjoining pit, invariably dug outside the hut-enclosure (Figure 3). When *katha* has thus been rid of the bulk of cutch and is partially dry, it is scraped from the cloth and made into lumps of irregular shape and arranged over closely-woven bamboo frames or *tattas* which are placed on wooden racks (inside the hut) with a free circulation of air to help further drying. All the drying is thus necessarily carried out slowly and in shade and the product so obtained is stored on the same racks till it is ready for despatching to the town markets where it is sold as the commercial *katha*.

The crude liquid (a solution of cutch and catechin) that has drained off and collected in the pit, as the result of frequent washing of the concentrated liquid spread in the sink, thickens on cooling and acquires a brownish black colour. *Chuna* (slaked lime) is often added to enable the paste to solidify further: flat cakes of this are then prepared and spread on the *chuna*-covered floor, exposed to the full sun for complete drying (Figure 3). This forms the inferior *katha* which is stored in any odd places on the floor and is sold to the local consumers in the village markets.

Thanks are due to Khan Saheb Abdul Jabbar, the former Divisional Forest Officer, Nagpur-Wardha Division, for affording facilities and supplying some details of working and manufacture for writing this article.

Note by S. Ramaswami of the Minor Forest Products Section:—

The method of cooling the hot liquid extract from the chips by pouring it into a sink full of cold water is curious and is not followed by the *katha* boilers in other places. The more usual practice is to

concentrate the extract to the desired consistency (which the professional *katha* boilers know by experience) and allow the liquid to cool for about 24 hours or more when the *katha*, which is easily soluble in hot water but only sparingly so in cold water, separates out and sinks to the bottom of the vessel. To facilitate this crystallization of *katha* some crystals of *katha* are sprinkled on the cooled solution for "seeding." When all the *katha* has crystallized out, the vessel containing it and the solution of catechu-tannic acid is emptied into a sanded pit. The sand absorbs all the solution of catechu-tannic acid, leaving a layer of *katha* which is removed when it has grown to a sufficient thickness.

A NOTE ON LARCH IN KULU.

By N. G. Pring, I.F.S.

Trevor introduced larch into Kulu in 1916 and the subsequent supply of seed of the following species *Larix europaea*, *L. leptolepis* and *L. griffithii* was also due to him. The first experiments were carried out under the supervision of Trevor and Parma Nand. The results fully justify the experiments and it is felt that they would be of interest to the *Indian Forester.*

Parbatti.—In 1916 an experimental nursery was formed in 1/7 Nakas in the Parbatti valley above Pulga at an elevation of 8,000 feet. *L. europaea* whose natural habit is the Alps and Carpathians and *L. leptolepis*, a tree of North-East Asia and Japan, were both sown. Two lots of sowings were made ; the first of them appear to have failed but the second, which was sown during the monsoon after soaking the seed in cold water for 12 hours, gave fairly good germination results. Half of the seedlings were subsequently transplanted in the Kalanchi Thach at 9,000 feet and the other were left in the old nursery ; at present both groups together contain 33 poles, 17 *L. leptolepis* and 16 *L. europaea ;* both groups, which contain some of each species, have been twice thinned and appear to be thriving. It is as yet difficult to give a definite opinion as to whether English or Japanese larch is the most suitable ; the lower and larger group appears to be the more flourishing,

which is probably due to the fact that it is growing on a well drained mica schist, while the higher group is growing on a stiff clay soil.

In 1928 a small nursery of *L. europaea* was formed in 1/6 Kalga at an approximate elevation of 8,000 feet; about 40 per cent. of the seed appear to have germinated, and in December 1932, 135 seedlings were planted out at the same elevation on a well drained open site. At the same time a similar nursery was formed in 1/7 Nakas at an elevation of about 8,500 feet but the seed is reported never to have germinated. In 1931 three ounces of *L. griffithii* from Sikkim was sown in the Pulga nursery at an elevation of 7,200 feet; germination was moderate but subsequently the seedlings were reported to have been uprooted as a result of frost.

It may be noted that all the above mentioned areas have a general northerly aspect and that the precipitation is both heavy and frequent, snow lying for four months or more.

Lower Kulu.—In 1916 *L. europaea* was sown in a nursery in Nagni 1/43 C. I. at an elevation of 7,500 feet and in 1917 and 1918 several hundred seedlings were transplanted. The plants were carefully transplanted with balls of earth in open areas including old burns; these plants were reported to be thriving until the disastrous fire of 1921 destroyed all except one group of thirteen trees near the Forest Rest House and a second group of nineteen trees above the forest road, in both cases the elevation being approximately 7,500 feet, the aspect westerly and the subsoil a fertile mica schist which produces high quality *kail* and spruce. The precipitation is less than at Pulga, the period from April till July being notably drier while snow lies for a much shorter period at Nagni. The group near the Forest Rest House, which has an average height growth of about 40 feet with less than 17 growing seasons, proves that larch is very much quicker growing in youth than deodar; the average girth at breast height is approximately one and a half feet. The other group contains a number of poles averaging about thirty feet in height and this height would probably have been greater had it not been for a number of large spruce in the surround. The remainder have suffered from domination and in some cases complete suppression by neighbouring pre-existing spruce and *kail* which have now been cut out. A year or two

ago a couple of larch were evidently removed in favour of deodar. In the case of two larch, of which the leading shoot had been overgrown by briars, subsequent growth continued horizontally instead of vertically ; this proves how intolerant of shade is larch. In March 1929 one lb. of *L. europaea* was sown at Nagni with very poor results. The sowings were reported as a complete failure but in 1931 twelve seedlings were counted growing in a nursery adjacent to the existing larch pole crop and it is possible that the inoculation of this bed may account for this result.

In April 1931 three ounces of *L. griffithii* seed was sown in boxes and nurseries at each of the following places :—

Pulga—7,200′. Manali—6,400′, Nagni—7,500′ and Najan—7,000′. At Pulga fair germination results were obtained but as mentioned the seedlings were killed subsequently by frost lifting. At Nagni the results were nil but at Manali and Najan the results from sowing in boxes were fairly successful, while nursery sowings were a failure. It may be mentioned that the 1931 summer rainfall and subsequent winter snowfall was much below average and that the beds on which seed was sown (except those at Pulga) were particularly ill adapted for drought-conditions. The best results were obtained in a mixture of two-thirds sandy loam plus one-third sand taken from the Beas river bed at Manali. Unfortunately a goat raided the compound one evening and selected one box as his objective, causing numerous casualties before retiring ; however, with the survivors and a number of seedlings at Najan, we have a sufficient nucleus to study the growth of *L. griffithii.*

A single European larch was recently discovered at Manali completely dominated by surrounding conifers and sweet chestnut. The growth was obviously retarded owing to suppression but it will be interesting to study growth as the result of the removal of overhead cover.

The existing larch plots are being transferred to the Silvicultural Research Division as Sample Plots and the Silviculturist is sowing all three species of larch simultaneously at various seasons and by various methods to discover the best method of planting on a large

scale in Kulu. That greater success has not attended endeavours up to date is due to a lack of record and continuity, but the results certainly justify the introduction of this valuable genus on a large scale.

[We regret that none of the photographs available are worth reproducing.—Ed.]

PLANT PATHOLOGY IN THE FORESTS OF INDIA.

PART II.—BY R. S. HOLE.

7. In the article in which he complained of lack of interest and progress in the pathology of forest plants in India (*Indian Forester*, Vol. 25, November, 1899, pp. 431—438), two fungi were particularly mentioned by Mr. Gamble as being especially injurious and dangerous in India, *viz.*, *Fomes annosus* (also commonly known by Hartig's name of *Trametes radiciperda*) and the fungus associated with the widespread mortality of *sissoo* in the Changa Manga plantation of the Punjab which, from his description, appears probably to be the well known *Fomes lucidus*. Alluding to the discovery of the former on deodar in Jaunsar, Mr. Gamble says " It is impossible to exaggerate the importance of this sad discovery." Both these fungi are, primarily, root-attacking species and it seemed to me that before we could hope to deal successfully with diseases of this kind it was essential to obtain a more detailed and accurate knowledge of the factors governing the healthy development of the roots of our Indian forest species than we then possessed. Attention was accordingly directed at first to a species which could be conveniently studied in the forest in the immediate neighbourhood of Dehra Dun, *viz.*, the *sal* (*Shorea robusta*) and work was commenced with young seedlings which could be easily manipulated in garden and laboratory experiments, in the hope that, to a large extent at least, general principles discovered in connection with one important species and with the roots of young seedlings might also be found to apply in the case of different species and of the younger roots of older trees.

Bad Soil Aeration.—The experimental work carried out at Dehra Dun on these lines has shown that *sal* seedlings can be grown quite

successfully and healthily in water-cultures and, therefore, that water as such is not at all injurious to the roots ; that when water is kept in contact with the upper layers of soil taken from a *sal* forest it rapidly loses its oxygen and becomes heavily charged with CO_2 and that, under such conditions, the roots of the seedlings growing in this soil are rapidly killed ; that a similar injurious effect can be produced in water-cultures with a high content of CO_2 whereas, with a low content of CO_2 and high content of oxygen, the roots remain healthy* ; and finally that the injurious effect in the forest soil can be produced or accentuated, under moist warm conditions, either by covering the surface of the soil with dead *sal* leaves or by the formation of a water-table near the surface of the soil.† The damage done to the roots by this factor of bad soil-aeration resembles that done by drought, in so far as the younger, thinner, more delicate apical parts are killed first and as the root becomes thicker and stouter towards the base it becomes progressively more resistant to damage, the thicker older portions of the roots being killed only when the injurious conditions are severe and prolonged.* Roots‡ damaged in this way, therefore, afford what would be considered, on *prima facie* grounds, to be ideal conditions for the attacks of parasitic fungi, inasmuch as portions of the roots are killed and are thus incapable of resisting attack, while other portions, although not killed, almost certainly have their powers of resistance considerably diminished.

The exhaustion of oxygen and accumulation of CO_2 in the soil is believed to be largely due to the action of the organisms engaged in disintegrating and breaking down the soil humus and organic matter and we should, therefore, naturally expect the damage from bad soil-aeration to be most marked in regions of heavy rainfall and warm climate and in the case of evergreen species which keep the soil constantly shaded.

* See *Oecology of Sal, Part III, Indian Forest Records*, Vol. V. Part *VI* (1916), pp. 99—101, also *Indian Forester*, Vol. 44 (1918), pp. 205—208. It is interesting to note that preliminary experiments carried out at Dehra Dun indicated that the roots of other important Indian trees besides *sal*, such as sandal and teak, are subject to similar injury from a high concentration of CO_2 and low content of oxygen.

† See *Indian Forester*, Vol. 44 (1918), pp. 202, 203 ; also *Indian Forest Records*, Vol. *VIII*, Part *II* (1920—21), pp. 12, 14, 15.

‡ See *Oecology of Sal, Part I, Indian Forest Records*, Vol. *V*, Part *IV* (1914), pp. 16, 17, 30 and 34.

8. *Polyporus shoreae.*—In the first place, it is believed that these facts have a direct and important bearing on the serious root-rot and mortality of *sal* which of recent years have attracted much attention in the moist fire-protected forests of Bengal and which are usually associated with the presence of the fungus *Polyporus shoreae.*—The preliminary experiments carried out with this fungus at Dehra Dun by Dr. F. Shaw of Pusa and Mr. Abdul Hafiz Khan showed that, although successful inoculations invariably resulted when mycelium was inserted in the wood of the stem at the base of healthy seedlings and saplings through a wound, no success was obtained with mycelium applied to the outside of healthy unwounded roots, so that, at present, it seems probable that this fungus cannot successfully attack healthy unwounded roots. It is significant also that, in these particular forests really healthy vigorous seedlings can only be obtained by clear felling and thoroughly aerating the soil by first burning all refuse and then restocking by artificial sowings combined with the cultivation of field crops. It is hoped that, in the young crops so created, the early re-establishment of the unfavourable soil conditions may be avoided, possibly with the assistance of judicious periodic firing. It is interesting to note that this mortality of *sal* was at first thought to be due to insect attacks but Dr. C. F. C. Beeson, who was then investigating the matter, came to the conclusion that insects were not the primary cause and wrote to me for suggestions. From the work I had done in connection with the factors affecting the healthy development of the roots of *sal* seedlings and from what I knew about the general climatic conditions of Bengal, it seemed to me, although I had not then personally visited the area, that an unsatisfactory soil condition was probably the primary factor responsible for the trouble. I wrote to Dr. Beeson accordingly and suggested that he should examine the roots of the dead and sickly trees. Acting on this suggestion, Dr. Beeson discovered the presence of *Polyporus shoreae* in 1914. In a letter to me dated June 29th, 1915, Dr. Beeson referring to this point wrote "It was at your suggestion entirely that I looked at the roots of *sál* trees in the first case. I have sent in no report on the enquiry so far and my opinion has not been asked for, otherwise it

would have been pointed out that I was acting on your suggestions." Dr. Shaw, Imperial Mycologist at Pusa, subsequently obtained good specimens of fresh sporophores of the fungus which rendered its full botanical description possible and this was first published in *Kew Bulletin*, No. 3, 1916, p. 72.

9. *Fomes annosus.*—In the second place, it is believed that these results probably have an important bearing on the damage done by *Fomes annosus*. In Europe, it has long been known that damage by this fungus tends to be especially prevalent in plantations of evergreen conifers established as a first forest crop on fallow or agricultural land. At first, the young woods usually thrive on such soils and the damage generally becomes noticeable some time after the evergreen crowns of the trees have established a complete and continuous shade over the soil and humus has begun to accumulate in, and on, the surface soil. These facts were well known to forest officers in Germany when I was a student there in 1896. In fallow and agricultural soils, also, the sub-soil is frequently compact and dense, owing to the absence of organic matter and of the roots of shrubs and trees. With the establishment of a close forest cover, the accumulation of organic matter, a constantly shaded and more or less moist surface soil and a tendency to produce a water table near the surface on account of the dense sub-soil, we have precisely the factors which, as shown above, tend to produce the conditions of bad soil-aeration which have been proved to be definitely injurious in the case of *sal*. That soil-aeration is the primary cause of the damage, in such cases, is now being increasingly recognized in Europe and consequently it is usually recommended that, in afforesting agricultural land, deciduous broad-leaved species should be mixed with conifers or that, in the first rotation on such land, these species alone should be grown as a preparation for the introduction of evergreen susceptible conifers. It appears probable, therefore, that the best method of preventing damage in future by *Fomes annosus* to deodar and other species in India will consist in taking greater care to establish plantations only in localities really suitable for the healthy development of the trees and to maintain, so far as possible, the

conditions of soil-moisture and soil-aeration which are most favourable for healthy root-growth throughout the life of the trees.

10. *Fomes lucidus.*—*Passing now to the root-disease of* ***sissoo*** (*Dalbergia sissoo*), it should be noted that the natural conditions under which this tree appears to grow best consist in a clean, well-aerated, gravelly, or sandy soil with a moving and well-aerated sub-soil water-table within reach of the tap-root, *i.e.*, in a well-aerated, clean surface soil and with an ample supply of well aerated sub-soil water which is probably of special importance in enabling the tree to remain in full foliage throughout the hot season and thus perhaps to escape injury by high temperature, drought and sun-scorch. When the surface soil is kept moist and humus begins to accumulate, rot frequently attacks the collar and the lateral superficial roots, even when there is an ample supply of well-aerated sub-soil water and the tap-root remains healthy below. On the other hand, the tree is very liable to suffer from drought when the sub-soil water-supply is scanty. Now in the Changa Manga plantation of the Punjab, where this species is very susceptible to the attacks of *Fomes lucidus*, the tree is apparently subjected to more or less considerable damage both from drought and bad soil-aeration. For its necessary water the tree is here primarily dependent on the supply obtained from irrigation which is irregular and frequently insufficient, on account of which the trees periodically suffer more or less severely from drought and sun-scorch. On the other hand, owing to the large proportion of mulberry in the plantation, the soil is well shaded by the heavy foliage when the trees are in leaf and there is a considerable addition of humus to the surface soil, while soil-aeration is also probably adversely affected by the plugging of the surface with a deposition of silt under the irrigation system of surface-flooding. Other probably adverse factors are the wounding of the roots in the work of clearing the irrigation channels and the probable assistance rendered to the fungus by the irrigation water in the way of distributing its spores. The true remedy for the disease of *sissoo* in this case appears, in fact, to lie rather in more adequate consideration being paid to the vital needs of the tree in respect of water and air than in a campaign directed against *Fomes lucidus.*

If the view here taken is correct that the factor of primary importance is a sickly condition of the tree induced by non-living environmental factors, we should expect to find secondary parasitic organisms of different kinds attacking the sickly trees in different localities. It is interesting to note that, in this instance of the *sissoo* tree, this does actually appear to be the case. Thus, Mr. Abdul Hafiz Khan has pointed out that, whereas the mortality of *sissoo* in Changa Manga is associated with *Fomes lucidus*, in Dehra Dun on the other hand the death of the trees with similar symptoms is found to be associated with the quite different fungus *Polyporus gilvus* (see *Indian Forester*, Vol. 49 (1923), p. 503). A similar state of things was noticed in the case of the spruce mortality mentioned in paragraph 11 below. The primary cause of the damage in this instance was sun-scorch, the damaged trees being subsequently attacked by the fungus *Armillaria mellea* and insects. In this case it was noticed that where conditions for infection by the fungus were apparently not very favourable, *e.g.*, on a hot, open, grassy slope with the trees widely scattered, the trees were chiefly attacked by insects, whereas, in dense forest on a cool, northerly aspect, *Armillaria mellea* was the most prominent secondary agent. (See *Indian Forester*, Vol. 53 (1927) pp. 486, 487.)

11. *Armillaria mellea.*—In connection with this subject of important root-attacking fungi, the recent discovery in 1922, of *Armillaria mellea*, in the Jaunsar forests, is also a matter of considerable interest. Of this fungus it has recently been stated that " more trees die, in Europe at any rate, from attack by this fungus than through any other parasitic agent. " (*The Fungal Diseases of the common Larch,* by W. E. Hiley, Oxford, 1919, p. 144.) A separate paper on the investigation made by myself in 1922 as to the connection between this fungus and the widespread mortality of spruce (*Picea morinda*) in Jaunsar should be referred to for details (*Indian Forester*, Vol. 53 (1927), pp. 434, 483), but here it is sufficient to note that, in this particular case, the inquiry showed that the primary cause of the damage to the spruce was sun-scorch, the exceptional severity of which was apparently chiefly due to decidedly deficient local rainfall and snowfall during the years 1918 and 1920; also that, although

Armillaria mellea was found widely distributed on a very high percentage of the dead trees, it appeared to be in this case only a saprophyte or possibly a weak parasite. The spruce investigation mentioned above also brought to light some additional facts of interest in connection with *Fomes annosus.* This fungus appears only to have been reported previously in India on the deodar (see *Indian Forester,* Vol. 29 (1903), November, Appendix series) but during this inquiry sporophores of this species were discovered, once on a dead wind-fallen silver fir (*Abies pindrow*) and twice on spruce (*Picea morinda*). Another interesting point noticed in connection with this fungus was that in none of the three cases in which its sporophores were seen could any distinct rhizomorphs be discovered in the immediate neighbourhood of the sporophores, although in one case it appeared that both *Fomes annosus* and *Armillaria mellea* were attacking one and the same tree. This indicated that the rhizomorphs previously found associated with the sporophores of *Fomes annosus* on deodar (*Indian Forester,* Vol. 29 (1903) l.c., Vol. 30 (1904), pp. 199, 200 and Vol. 31 (1905). p. 489) possibly belonged to *Armillaria mellea* and that therefore *Fomes annosus* probably does not produce rhizomorphs. This is a point of considerable importance which requires further investigation.

12. *Rusts.*—This inquiry incidentally brought to light a point which is of interest in connection with the damage done to forest trees by the great group of the fungi popularly known as the Rusts (*Uredinales*). In connection with the mortality of spruce alluded to above, reports by the local forest officers had emphasized what appeared to be an unusual prevalence of the spruce rusts (probably chiefly *Barclayella deformans*) and it is therefore possible that, in some cases at least in which unusually severe damage by rusts has been reported, the primary cause of the injury is to be sought in some external factor, such as drought, sun-scorch, or bad soil-aeration, which materially weakened the vitality of the trees, rather than in these particular fungi which are practically always present in the forest and which, as a general rule, do very little damage. This is a point which should be borne in mind, for instance, when considering the following remarks regarding

the attacks of *Aecidium* (*Peridermium*) *piceae* on the Himalayan spruce, *as reported by Dr. E. J. Butler* :—

"Mr. Oliver informed me that he had seen trees in Chakrata Cantonment in 1902 dying or dead from the effects of this fungus. This was due to the loss of all infected needles in 1901, when the attack was very severe. The trees were so weakened in consequence that they were unable to make new shoots or only put out feeble ones. None of the conifer rusts in the Himalaya have been hitherto described causing such damage as this." (*Indian Forester*, Vol. 31 (1905) p. 614.) Again, Professor R. S. Troup has drawn attention to what appears to be unusually severe damage to deodar by *Aecidium* (*Peridermium*) *cedri*. (*Indian Forester*, Vol. 40 (1914), p. 469, and *Silviculture of Indian Trees*, Vol. *III* (1921), p. 1108). The most severe damage appears to have been noticed by him in the Manali plantations of the Kulu Division in the Punjab which are believed to be situated in a moist valley in a locality not well-suited for the healthy growth of deodar and where possibly the trees are liable to damage from unsatisfactory conditions of soil-aeration. In a recent letter to me on the subject, Professor Troup writes that he did not examine the root-systems of the diseased trees in question. This is a matter, therefore, which seems to require further investigation. If the trees in this case are suffering primarily from unsatisfactory conditions of soil-aeration, it is possible that careful investigation will show that *Fomes annosus* is also present in this locality and is attacking the more or less sickly roots in the soil.

POLYPORUS SHOREAE (*SAL* ROOT FUNGUS) IN BAHRAICH DIVISION.

BY D. DAVIS, I. F. S.

It may be of interest to record some observations on the attack of this fungus made by the writer in 1928 and 1929, when he was in charge of Bahraich Division, and again in February 1933 during a tour through the same areas.

Polyporus shoreae, a basidiomycete fungus, attacks the roots of *sal* (*Shorea robusta*), spreading chiefly by means of rhizomorphs, (bundles of mycelium), underground, and also probably by spores carried in the air. The attacked roots generally become completely rotten, the wood showing a distinctive brown and white honeycomb effect, and an attacked tree frequently dies comparatively quickly. The sporophores of the fungus appear during or just after the monsoon in the form of large dark brown brackets at the base of the tree. This fungus probably occurs sporadically in most *sal* forests, especially in the plains, but it does not appear to have been recorded as doing any widespread damage. It is usually found attacking trees either singly here and there, or in small groups. It had been noticed to a limited extent in most of the *sal* areas of Bahraich Division from the time the writer first went there in 1923. But a very serious attack was observed at the end of the monsoon of 1928, the worst being in compartments 68 and 69 in the south of Motipur Block. In these two compartments trees were dying in large numbers over an area of about 500 acres. The forest is of the typical plains type, and is of rather poor quality. A wide shallow depression runs through the affected area. Large numbers of trees of all sizes had the fungus sporophores at the base, and of these many were dead, others were obviously dying, while some were still green and healthy looking. Other trees were also found to be dead and dying, almost certainly from the fungus, though no sporophores were visible. The attack was worst in and near the large depression, though a good many trees on the higher ground were also affected.

It appears probable that the fungus grows better and spreads more quickly in low-lying ground, and that excessive moisture favours it. The following facts lend support to this opinion. The worst attack was in the lower lying ground. Also during the period June 1927 to July 1928 the rainfall was largely in excess of the normal, a peculiar feature being that the cold weather of 1927-28 was throughout a very wet one, the Bahraich rainfall figures for November 1927 to February 1928 being 9·58 inches compared with the normal of 2·12 inches. This wet cold weather following an excess of rain in the

previous monsoon (50·21 inches compared with the normal of 37·56 inches for June to September 1927) meant that the ground never really got dry. This almost certainly encouraged the spread of the fungus and accounted for the exceptionally bad attack.

The affected area was due to be marked for regular fellings in the season of 1928-29. All dead and obviously dying trees were therefore marked in December and January. By the following May (1929) many more trees had died or were dying, and these were also marked. The number of trees marked was as follows :—

	Dec.—Jan.	May.	Total.	
Dead ..	374	83	457	1,795
Dying ..	612	726	1,338	

Some of these marked trees were in other parts of the compartments not apparently affected by the fungus, but in the affected area of about 500 acres it was estimated that at least 1,000 and probably nearer 1,500 trees were either dead or dying as a direct result of the fungus attack.

But in spite of such large numbers of trees having died, many of them very quickly, it was noticed that a good many trees were slow in dying, and by May 1929 many trees, which had shown signs of dying in November 1928, were still alive, and some, which actually had sporophores of the fungus at their base, were still quite green and healthy looking. In order, therefore, to get some idea of how quickly affected trees died, and of whether trees once affected ever recovered, 140 trees, which had fungus sporophores on them and were thus definitely attacked, but which were still green and not marked as obviously dying, were ringed and numbered with coaltar, and a record was started, in which periodical entries were to be made as to the condition of the numbered trees. This was done in May 1929. The writer left the Division shortly afterwards, and did not see these areas again until February 1933. During the intervening 3½ years the fungus

attack did not spread, and appeared to have died down. The 1,795 trees marked in 1928-29 were felled in 1929-30, but after that only a comparatively few dead and dying trees were felled for departmental purposes or for concessionists. The register of ringed and numbered trees had been kept up, though the trees had only been examined in November 1929 and December 1930. In February 1933 a careful examination of the area was made, and the following notes were made concerning the 140 trees ringed and numbered in May 1929 :—

7 Dead (1 died in 1929, 3 in 1930, and 3 in 1933).

5 Untraced, probably dead (4 were more or less dying in 1930, and 1 was apparently healthy in 1930).

25 Dying (8 actually had fungus sporophores at the base in February 1933).

31 apparently healthy, but with sporophores at the base in February 1933.

72 apparently healthy, and no sporophores at the base in February 1933.

It is thus obvious that trees attacked by the fungus often take several years to die, and may throw off the attack and not die at all.

It is also probable that the unusually dry weather of 1928-29 checked the fungus and helped many trees to recover from its attack. The large excess of rain up to July 1928 was followed by a period of deficient rainfall, there being only 9·3 inches from August to October 1928 compared with the normal of 21·5 inches, and from November 1928 to May 1929 there were 2·85 inches compared with the normal of 4·42 inches. Thereafter rainfall was more or less normal until the cold weather of 1931-32 and the monsoon of 1932, when rainfall was again deficient.

To summarise the conclusions arrived at :—This fungus is present to a greater or lesser extent in most plains *sal* forests in the U. P., (it has been observed by the writer in many parts of Gorakhpur and also in Pilibhit, and has, I think, been reported from other Divisions, *e.g.*, South Kheri), and it is most likely to be found in poorly-drained areas of poor quality forest. Although it is always killing trees scattered here and there singly or in small groups, it does not as a rule spread

very quickly, and is unlikely to be a serious pest, unless exceptionally favourable rainfall conditions cause it to spread as rapidly as it did in *Bahraich* in 1928. Excessive monsoon rainfall by itself is probably insufficient to affect its spread to any extent; but if this is followed by an abnormally wet cold weather, so that the ground never gets really dry, then a serious outbreak may occur, especially in low-lying poorly drained areas. If a serious attack occurs, it appears to be unwise to fell all attacked trees, unless they are actually dead, as attacked trees may not die for a considerable number of years, and may often recover completely (though this remains to be proved). It is also probable that the outbreak will die down by itself, especially if followed by seasons of deficient rainfall. It is, however, fairly certain that in areas where the fungus has once got a hold it will remain, and will periodically kill a few trees. But its spread will normally be very gradual. This has been constantly observed in Bahraich, and during this last visit in February 1933 a fair number of recently affected trees was observed near the ones ringed in 1929. The fungus thus appears to have left many of the trees attacked in 1928-29, but to have spread slowly to fresh trees. Some of these newly affected trees had recently died, and others were still green, though with fungus sporophores at their base.

Two interesting phenomena observed in 1928 in connection with the appearance of sporophores may be mentioned. In two cases sporophores were seen on old dead stumps, one being of a *sal* tree which had been felled at least three or four years previously, as a large bush of *Mallotus philippinensis* had grown up right over the stump. The other stump was of a *sal* tree felled one or two years previously. In two other cases sporophores were seen coming out of the ground two feet away from the base of a tree.

In conclusion it may be mentioned that the usual method suggested for checking the spread of the fungus (but never, as far as I know, actually tried), *viz.*, digging deep trenches round the affected area, will probably not be very effective. The area in which the above bad outbreak occurred has a railway line running through it. The main area affected is on one side of the railway, and a comparatively

narrow strip of forest is on the other side, and the railway line has a 100 feet wide cleared strip on each side of it. Previous to 1928 a few trees had been noticed dying of the fungus in the main block of forest, but no attack had ever been noticed in the narrow strip on the other side of the railway. If a trench is of any use in stopping the spread of the fungus, it is almost certain that a 200 feet line devoid of *sal* trees would also stop it. But the outbreak was almost as bad in the narrow strip as in the main block of forest. It is, therefore, probable that the fungus in this case spreads by means of spores, though there is no proof of this. Another fact which tends to show that it spreads by means of spores as well as rhizomorphs is that it so often occurs in widely scattered isolated patches. New affected patches have often been noticed at some distance from older ones, there being no sign of attack on any of the intervening trees.

HOW TO KILL RATS IN NURSERIES AND GARDENS.

BY H. S. JAMWALL, KASHMIR FOREST SERVICE.

1. The readers of the *Indian Forester* in general and forest officers in particular will be interested to know the following easy and cheap method of killing rats in nurseries and vegetable gardens. The method has been tried successfully in this division and will surely be found very useful elsewhere where rats are considered a nuisance in destroying nursery seedlings and garden plants.

2. (*a*) Take an ordinary kettle or earthen pot and invert it on the ground and bore a hole on the back of it. The hole should not be bigger than one inch in diameter, care being taken that the kettle does not break in making the hole in it.

(*b*) Fill the kettle as tightly as possible with *dry pine needles*.

(*c*) Find out quite fresh rat holes in the nursery or the garden. They can easily be spotted from a heap of fresh earth at the mouth of each hole.

(*d*) Invert the kettle with mouth downwards over the rat hole and press loose earth around its mouth.

(*e*) Then with a match ignite the pine needles through the hole in the kettle and blow it till dense smoke is visible all round the mouth of kettle.

(*f*) If pine needles are not available old rags can be used instead for burning in the kettle.

The smoke enters the rat hole and all rats therein are killed immediately. In fact the smoke passes through the crevices, into the numerous old and new holes up to a distance of a few yards and kills all rats in this area. The operation is so simple, easy, cheap and effective that one does not have to spend a farthing on anything, as one can use in this even old kettles rejected by villagers.

3. Finally the writer believes that in these days of financial stringency, it is better to resort to such simple and inexpensive methods rather than buy and use chemical poisons, heretofore suggested by various workers for destruction of rats.

REVIEWS.

AERIAL PHOTOGRAPHY—METHOD OF DETERMINING TIMBER SPECIES.

By Harrison C. Ryker in the March 1933 *Timberman* (Vol. XXXIV, No. 5).

The results of the author's experiments, discussed in detail in this well illustrated article, constitute an important advance in forest photography. In an endeavour to obtain aerial pictures in which tree species could be identified, he photographed a coniferous forest tract through 36 different lens filters, ranging through all the colours of the

spectrum from blue to red, on to two improved types of film,—Eastman Supersensitive Panchromatic and Eastman Panchromatic "K" (infra-red). Pictures made through green filters on the Supersensitive Panchromatic film proved far superior, and those made through the three filters No. 55 (Stereo green), No. 59 (Projection green), and No. 64 (Green minus red 3 light) when viewed through a magnifying stereoscope "depicted the timber so that species was positively identifiable." As these filters transmit only light wavelengths of from 460 to 620 millimicrons, judging by its photometric absorption curve filter No. 40 (Cine green) could also be used successfully. The photographs taken on infra-red film were of no practical value for identification purposes.

The method of identification developed was based on crown monotone colour and crown shape. The test area, in California, was an open stand (trees growing far enough apart to see some ground between them from the air) containing mature trees of (*i*) Douglas fir, *Pseudotsuga taxifolia*, (*ii*) Western Yellow Pine, *Pinus ponderosa*, (*iii*) Sugar Pine, *Pinus lambertiana*, (*iv*) Incense Cedar, *Libocedrus decurrens*, the foliage colours of these species being deep yellow green, yellow green, blue green and light yellow green. When photographed through the green filters the sunny side of these trees and those trees near the centre of the picture appeared in the following monotone colours or shading :

(*i*) darkest gray, (*ii*) light gray, (*iii*) lighter gray, (*iv*) lightest gray. The shady half of the trees photographed as follows :—

(*i*) dense dark core with sharply defined halo, (*ii*) tenuous dark core with broad badly-defined halo, (*iii*) open crown with very light gray top and broad irregular halo, (*iv*) dense core with narrow well-defined halo. The distinguishing features of photographic appearance of crown shape were classified : (*i*) sharply pointed conical, (*ii*) long columnar crown, blunt or tufted tops, (*iii*) tallest, broadest, with flat spiked tops, (*iv*) narrowest shortest crown, acutely pointed tops.

Using the above "photographic appearance components" the author was able to identify the species of each individual mature tree ; to locate trees with foliage affected by pests ; and to determine

boundaries of areas predominately pine as against areas predominately fir. This in addition to the usual data obtained from aerial photographs on topography, boundaries of blanks, types, etc., relative size of trees, and height of trees, which can be measured by parallax determinations within a limit of error of 5%. The validity of Ryker's method was proved by a check on the ground.

The experimental photographs were taken from an altitude of 6,500 feet above ground, giving a picture scale of 6·6 inches to the mile. The author recommends this as the minimum scale for detailed identification of individual trees.

The use of a green filter with Supersensitive Panchromatic film would appear to be advantageous in ordinary forest photography on the ground. The reviewer has used the "Super-pan" film in cinematography in the Andaman forests, although unfiltered or with yellow filters only (which Ryker found to be greatly inferior to green filters), and can testify to the superiority of this film over ordinary Panchromatic or Orthochromatic.

J. KENNETH PEARCE.

PRUNING AND CROPPING.

By D. Norris, M.Sc., A. I. C.

(Bulletin No. 15 of Indian Lac Research Institute. Price 1/4/-).

This pamphlet contains much useful data as to the amount of cutting back which can usefully be done to encourage the output of lac from *Schleichera trijuga* trees. The *kusum* is one of the most widely used trees for the production of lac in India because its lac is of high quality and also because the tree grows to a larger size than most species which carry lac and so gives a larger yield of stick lac. It can also give two crops of lac a year and the fresh flush of leaves at the beginning of the hot weather serves to protect the lac insects to some extent.

Miss Norris criticises the usual practice of partially infecting the *kusum* tree and leaving it for three years to produce a full crop. Instead

she recommends a much heavier infection which will yield a full crop in a much shorter period, followed by systematic pruning down to a maximum branch size of $1\frac{1}{2}''$ diameter without interfering with the natural shape of the tree, followed by a short rest period before re-infection.

R. M. G.

POCKET GUIDE AND TABLES FOR THE MEASUREMENT OF TIMBER.

BY PANDIT DAYA RAM SHARMA, D.D.R.

In addition to tables for finding out cubic contents of logs and scantlings which are given in Mercer's tables also, this book contains tables for measuring work of sawyers in superficial feet, a table of cubic feet corresponding to cubic *tussoos,* and a table of girths corresponding to diameters. This book gives the cubic contents of logs and scantlings up to two places of decimals while Mercer's gives up to one place of decimal only.

As Mercer's tables are standard tables for measuring the volumes of logs and scantlings in cubic feet, the author would have done useful original work for his province (Kashmir State) if he had prepared tables for reading cubic *tussoos* directly. It may be noted here that a *tussoo* is not an *Indian* measure as it is not used in many parts of India, and the word Indian repeatedly mentioned on page 6 and elsewhere is misleading.

There are some mistakes in the tables, *e.g.*, page 123, the volume of a scantling $18' \times 1'' \times 10''$ should be 1·25 instead of 1·24 and $18' \times 1'' \times 11''$ should be 1·38 instead of 1·37 which indicate that other items may also need checking. This book should, however, be of considerable use to those dealing with timber work, particularly in areas where the *tussoo* is the unit of measurement.

M. A. KAKAZAI.

EXTRACTS.

THE ECOLOGY AND SILVICULTURE OF THE HIMALAYAN SPRUCE AND SILVER FIR.

[THIS PAPER FORMS PART I OF A CONTRIBUTION BY PARMA NAND SURI, P.F.S. PRESENTED AT THE PUNJAB FOREST CONFERENCE, FEB. 1933.]

I.—Introduction.

1. Spruce (*Picea morinda*) and silver fir (*Abies pindrow*) constitute the major area of the Punjab coniferous forests. Until about 1915, however, they were considered of no commercial value and in consequence aroused little silvicultural interest. Their regeneration under scientific principles commenced for the first time in 1915-16 when the virgin spruce and silver fir forests in Pulga, Nakas and Kalga blocks of the Parbatti valley of Kulu were worked for export on a commercial scale under a definite system, being marked personally under what Mr. Trevor considered a suitable seeding felling. It was about this time that the revision of the Kulu Working Plan was commenced, and in this plan almost all the workable spruce and silver fir forests were brought under proper management as it was considered that a large permanent demand for these species would be established. This aroused an interest in the silviculture and regeneration of these species. The results of observations and small scale experiments, carried out in Kulu and Seraj Divisions in the period 1915-1921, were incorporated in a joint paper " A note on the silviculture and regeneration of the Himalayan spruce and silver fir " by Messrs. Parma Nand and Wright which was presented to the 1922 Punjab Forest Conference. Unfortunately, this was followed by a slump in the timber trade and with it the zeal for research in the silviculture and regeneration of the two Indian firs abated. No serious attempts were made to carry out the experiments approved by the 1922 Conference except those started by Mr. Kitchingman in Lower Bashahr Division in 1923 which unfortunately gave no tangible results and had soon to be discontinued. The F. R. I. small scale experiments on the manipulation of canopy, humus and grazing, started in 1914 in Lower Bashahr, gave no positive results and were abandoned in 1926. No further research work was done in this direction until 1930 when the subject was again taken up for discussion at the Punjab Forest Conference and interesting papers by Messrs. Parnell, Glover, Flewett, Pring and Deans were read and discussed resulting in recommendations for the carrying out of certain nursery and forest experiments based on the lines of research approved in the 1922 Conference. A resolution was also passed urging the appointment of a Provincial Silviculturist for the Punjab to deal with this and many other problems requiring investigation. The Silvicultural Research Division was created in September 1930 and the subject of this paper was included in the triennial research programme. In February 1931, Mr. Glover presented to the Punjab Forest Conference a very interesting paper " A short note on the ecological changes in the forests of the Eastern Circle " in which he pointed out the need for the scientific survey of the soil flora of regeneration areas and detailed the preliminary observations made by him in the course of his tours.

2. A survey of the spruce and silver fir forests in Kulu was made in 1931 and a systematic study in the field based on the observations made in previous years was commenced and continued during 1932. The results of two years' work are discussed below.

II.—The ecology of the spruce and silver fir forests.

3. A brief outline of the local geogaphy and past history of these forests will be helpful in appreciating the differences in their composition and distribution which will be noticed in the course of this paper. For further details reference may be made to Trevor's Kulu Plan.

4. *Situation.*—The Kulu forests are situated in the inner Himalayas between North latitude 31° 23′ and 32° 26′ and East longitude 76° 59′ and 77°—50′. They are separated from the outer Himalayas on the west (Bara and Chhota Bangahal) and from the innermost Himalayas on the north and east (Lahaul and Spiti) by lofty mountain ranges.

5. *Drainage.*—Except a part of Seraj (Outer Seraj) which lies in the Sutlej valley, the Kulu forests are situated in the Beas valley which runs practically from north to south. The basin of the Beas is drained on the left by a series of more or less parallel streams, *viz.*, the Parbatti, the Hurla and the Sainj forming distinct valleys and running all from north-east to south-west. The Tirthan, with its tributaries (Bathad, Jibi and Manglaur khads), draining Inner Seraj, discharges into the Sainj in a north-westerly direction just before the latter joins the Beas. These side valleys are comparatively narrow and steep to precipitous. The portion of Seraj lying in the basin of the Sutlej valley is mainly drained by the Ani and Kurpan streams with their small tributaries, both running from north to south. Except the headwaters of the Kurpan which is close, steep and precipitous, these valleys are fairly wide.

6. *Configuration of the ground.*—The slopes vary greatly. The fir forests are generally situated on moderate to steep slopes except in the Monalsu and Mohal khads in the main Beas valley, in Shat Nal, Jail Nal and Grahan Nal in the Parbatti valley and in the Hurla, Upper Sainj, Tirthan and Upper Kurpan valleys, which are very steep to precipitous.

7. *Rock and Soil.*—The principal rocks are gneiss, shales and micaceous schist with occasional bands of granite. The soil derived from these rocks is micaceous loam or clay loam. It is well-drained on steep slopes and precipices but moist conditions are common where the slope is moderate, the soil is almost invariably deep and fertile. The ground in remote areas is often covered with a thick layer of old needles whereas in the vicinity of villages it is fairly bare due to the continual removal of litter or *suhar*.

8. *Rainfall.*—The rainfall in the spruce and silver fir forests varies from about 45″ to 70″, falling mostly during the monsoon period—July to September. The precipitation increases with elevation and more rain falls towards the heads of the valleys. The snowfall is heavy during the winter and snow lies long on northern slopes and at high elevations. There are thunder showers during the spring and summer.

9. *Composition of the forests.*—The spruce and silver fir forests lie between 7,000′ to 11,000′ favouring mostly the cool northern, north-eastern and north-western aspects, though at high elevations they are occasionally met with on eastern and western aspects. The growing stock is generally mature to over-mature. Three altitudinal zones are distinguishable :—

(*i*) 7,000′ to 8,000′.
(*ii*) 8,000′ to 9,500′.
(*iii*) 9,500′ to 11,000′.

(*i*) In the lower zone spruce predominates either pure, or associated with *Cedrus deodara* or *Pinus excelsa* or with both. In the upper limits of this zone some silver fir appears also in mixture. Hardwoods such as horse-chestnut, walnut, maple, elm, poplar, etc., are also met with either mixed singly with spruce or gregarious in patches and damp valleys.

(*ii*) In the middle zone, silver fir predominates occurring either pure, or associated with spruce or with blue pine and spruce or with spruce and deodar. In depressions hardwoods are also met with, gregarious or mixed singly with silver fir. The silver fir-yew association is also not uncommon in this zone.

(*iii*) In the top zone, birch (*Betula utilis*) and brown oak (*Quercus semecarpifolia*) predominate with patches of silver fir, pure or mixed, also with *Rhododendron campanulatum* and *Pyrus aucuparia.*

The altitudinal zones given above are only approximate. Aspect and the nature of the country are more effective than altitude in determining exactly where a certain type ends and another begins.

10. *Past history.*—A short history of the belt of spruce and silver fir is essential to give an idea of the extent to which human intervention has influenced past conditions :—

(*i*) *Fellings.*—The Kulu forests were constituted protected and reserved forests in 1895-96. They were brought under management in 1897 when the first working plan came into force. Trees other than deodar were classed as inferior species and fellings were limited to right-holders, the trees being cut in unregulated fellings. This has resulted in excessive removals along the lower belt of the fir forests of Upper Kulu. Elsewhere little felling had taken place until work commenced in 1915.

(*ii*) *Grazing.*—The spruce and fir forests in the Beas valley have long been heavily grazed over by sheep, goats and cattle.

(*iii*) *Fires.*—Fires are only exceptional and very rare. Fires have been known, *viz.*, Niaragarh in 1921 and such conflagrations generally result in the total destruction of the growing stock.

(*iv*) *Lopping.*—The spruce is badly lopped for manure and charcoal in Upper Kulu and Seraj where forests in the neighbourhood of villages have been ruined. This malpractice is unknown in the Parbatti and Hurla ranges.

(*v*) *Removal of litter.*—Litter or *suhar* is removed in Upper Kulu from the vicinity of villages. This practice gives a clean bed for regeneration purposes. In the remote

forests and in localities where *suhar* is not removed, the forest floor is often covered with a thick layer of old needles.

11. *The evolution of spruce and silver fir forests.*—(*i*) Mr. Glover has dealt with the ecological changes in coniferous forests and the causes of such changes in some detail in his paper " A short note on ecological changes in the forests of the Eastern Circle."

(*ii*) The evolution of spruce and fir forests can best be studied in (*i*) landslips, snowslides, abandoned cultivation and grass lands, (*ii*) burnt areas, (*iii*) gaps of various sizes in the forests, (*iv*) heavily logged areas, (*v*) heavily grazed areas, and (*vi*) virgin forest, long protected against grazing and fire. A detailed study of the successional changes under various conditions is a matter of time. An analysis of the associated soil flora is still incomplete and the following remarks are, therefore, only confined to the tree flora.

(*iii*) Blue pine has a wide range of elevation, 5,000′ to over 10,000′ and with fire protection, is the first conifer to come in on grass lands, landslips, snowslides, abandoned cultivation and burnt areas, *e.g.*, Kawargarh (6,000′ to 7,000′) and Shalingarh (7,000′ to 8,000′), where extensive grassy hillsides are now covered with blue pine which has appeared since fire protection was established, and parts of Tosh Nal, C. V. (9,000′) where a big snow slide is now stocked with pure blue pine in the sapling stage (Preservation Experimental Plot No. 10). Landslips in depressions on cool aspects are first invaded by hardwoods, *e.g.*, parts of Monalgahr 2/6, C. I. (Preservation Experimental Plot No. 29). As fire protection continues, the blue pine canopy closes, conditions become mesophytic and pure blue pine crops are invaded by spruce (parts of Jhangar Kalaun in Kulu, and Reona in the Parbatti), or by deodar (Riacha Thach, Tarai Jhakar and Paneo, Outer Seraj), or by both (Riacha Thach). Thus, mixed forests of blue pine and spruce or blue pine, deodar and spruce originate. Blue pine gradually recedes to drier and warmer situations, yielding the rich moist ground to its successors. The lopping of pine helps the extension of deodar, and finally a pure forest of deodar or deodar mixed with spruce results. Similarly, in the blue pine-spruce mixture, the blue pine is eventually ousted and a pure spruce forest is evolved. In time, with fire protection pure deodar forests also are invaded by spruce, examples of which are common in Seraj, and once again a mixed forest of deodar and spruce results. Takrasi, Kalandi Dhar, Chotar, Kut, Sharau Nal are outstanding examples of this type.

(*iv*) Hardwoods, in time, are invaded by both spruce and silver fir, and as the fir crop grows up, the canopy of the hardwood thins and a forest of spruce and silver fir with hardwoods in the under-storey is formed. (Experimental Plot No. 14 and Preservation Experimental Plot No. 29).

(*v*) With close cover and fire protection, soil conditions become more mesophytic, and silver fir creeps into the upper limits of pure spruce, *e.g.*, Jaungi 2/23, C. I. In time, spruce failing to regenerate, the forest assumes an appearance of a selection type, with large overmature spruce standing scattered amidst silver fir of all sizes (Preservation Experimental Plot No. 46, Jaung R/7, Lower Kulu). A similar succession follows

in mixed forests of blue pine and spruce; silver fir intrudes, pine is gradually ousted and a selection type of forest of spruce and silver fir is formed. The overmature spruce trees decay and gradually disappear and the openings thus created being too small for spruce are regenerated with silver fir.

(*vi*) In the 8,000′ to 9,500′ zone, as a result of protection against fire and grazing, the blue pine crop closes up, soil conditions become mesophytic and both spruce and silver fir gradually come in, forming mixed forest of blue pine, silver fir and spruce. The succession is most marked in Tosh Nal, Kalga, Nakas, Bandag and other forests at the head of the Parbatti valley. The following enumeration figures made in a virgin forest of this type will be of interest:—

(1) *Nakas* 1/7, *C. I.*—

Species.		*I C.*	*II & III C.*
Kail	..	1,048	1,192
Firs	..	2,487	2,290

(2) *Nakas* 1/7, *C. II.*—

Species.		*I C.*	*II C.*	*III C.*
Kail	..	1,239	501	751
Firs	..	2,190	811	1,573

Mark the preponderance of mature trees in the crop and the ridiculously small number of the lower diameter classes. As this crop advances in age, owing to close cover, fire protection and negligible grazing, soil conditions become all the more mesophytic. Pine is gradually ousted, leaving in time, first a mixture of silver fir and spruce and then pure silver fir. This is happening to a marked degree in Tosh Nal and Bandag. The following enumeration figures of Bandag (which is at a higher stage of evolution), read with the figures given above, will illustrate the extent to which *kail* is being ousted:—

Species.		*I C.*	*II C.*	*III C.*
Kail	..	116	88	132
Firs	..	4,994	1,335	1,698

Examples are not uncommon where a pure mature blue pine forest is being completely invaded by spruce fir in the lower (Reona), and silver fir in the higher zone (Swajni). In mature mixed forest of silver fir, spruce and blue pine of the above type, mature and over-mature pine is frequently surrounded by well established sapling to pole crops of silver fir, with regeneration of both pine and spruce entirely wanting (Tosh Nal—Preservation Experimental Plots Nos. 9 and 11). At a later stage, the soil conditions become so humid that even silver fir cannot hold the ground and *Taxus baccata* forms an almost complete under-storey under-mature and over-mature silver fir and spruce (northern half of Preservation Experimental Plot No. 9.—Tosh Nal). This is the climax type of coniferous forests in Kulu and regression now sets in. The mature and over-mature spruce and silver fir trees begin to decay and fall one by one. The openings thus created are first colonized by shrubs like *Deutzia corymbosa, Lonicera angustifolia* and *Viburnum nervosum.* They are followed by hardwoods such as *Acer.* spp., *Corylus colurna, Prunus padus,* etc., amongst which spruce and silver fir begin to come in. When, however, a landslip or snow slide occurs or a severe fire breaks out, blue pine, the pioneer species, again colonizes the ground, thus made bare, and the same succession is repeated.

(*vii*) Above 9,500′, the pioneer species are birch and the high level oak. The establishment of complete canopied crops coupled with rigid fire protection quickly accomplishes the change to mesophytic conditions and silver fir appears on the ground but is only established in groups or as single scattered trees.

(*viii*) The origin of the mixed forests of deodar, spruce and silver fir commonly met with in the steep precipitous side valleys of Kulu, is difficult to explain but it is likely that here deodar was the first to occupy the ground, silver fir and spruce following in succession and ultimately inhibiting all regeneration of deodar (Rolla R/6 of Inner Seraj).

12. *Spruce and silver fir forest types.*—The following five primary types based on dominant species in the overwood have been distinguished :—

(*i*) The *Picea-Pinus-Cedrus* type.
(*ii*) The *Picea-Abies* type.
(*iii*) The *Abies-Picea-Pinus* type.
(*iv*) The *Abies-Picea-Cedrus* type.
(*v*) The *Abies-Betula-Quercus* type.

The above types are easily recognizable by every forester and form the basis of the study of ecology and silviculture of these forests. Each type is briefly described below :—

(*i*) **The Picea-Pinus-Cedrus type.**—This low level type occurs from 7,000′ to 8,000′. Mature and over-mature spruce is found either pure or mixed with blue pine or deodar or with both, in open as well as close canopies. In the higher limits of this type, silver fir begins to intrude. The lower belts of spruce and silver fir forests in Upper Kulu and the Sarvari valley are pure spruce, *e.g.*, Kangni, parts of Bajraundi, Jaungi, Parol and Marhaun. Mixed spruce and pine are met with in Deoban, Reonsigahr and parts of Molagthana. Parts of Bajraundi in Upper Kulu, Sharau Nal in Inner Seraj, Takrasi, Kalandi Dhar, Chotar and Kut in Outer Seraj, may be mentioned as examples of spruce and deodar mixture. In this type, hardwoods such as *Aesculus indica*, *Juglans regia*, *Celtis australis*, *Ulmus wallichiana*, *Alnus nitida*, *Populus ciliata*, *Acer* spp. are also met with on cooler sites, either in extensive pure hardwood patches or with spruce fir interspersed with them. The principal associate ground vegetation is :—

Shrubs—

Indigofera gerardiana,	*Viburnum nervosum*,
Desmodium tiliaefolium,	*Plectranthus rugosus*,
Spiraea lindleyana,	*Rubus niveus*.

Herbs—

Senecio rufinervis,	*Iris nepalensis*,
Pteris aquilina,	*Salvia glutinosa*.

In Upper Kulu and Sarvari valley, pure spruce forests have been over-felled and over-grazed by right-holders. In accessible areas of this type, litter is removed and the soil is exposed. In remote forests, the ground is covered with humus but the layer is not more than 2″ to 3″ deep. In the vicinity of villages, spruce fir is badly lopped, both in Upper Kulu and Seraj, the worst examples being Kangni in Upper Kulu and Kalandi Dhar in Outer Seraj. Weed growth is scanty to absent where grazing is

heavy, though *Plectranthus*, *Viburnum*, *Senecio*, *Iris* and *Pteris* are common. Fires are rare in these forests. The ground is easy and the floor is generally in a suitable condition for regeneration.

(*ii*) **The Picea-Abies type.**—This type occurs approximately at an elevation of 8,000′ to 9,500′. In the lower limits of this altitudinal zone, spruce predominates while in its upper limits silver fir is the principal species. Invasion of silver fir, tending to oust spruce, is well marked in certain localities, especially in the lower limits of this type, *e.g.*, Jaung R./7, C. I. (Preservation Experimental Plot No. 46) and Hathipur 2/60, C. I. (Lower Kulu). Mature and over-mature, close canopied uniform crops are met with, *e.g.*, Bandag 2/60, C III, and parts of Kalga and Nakas in the Parbatti valley. Patches of hardwoods such as *Juglans regia*, *Acer* spp., *Prunus padus*, *Corylus colurna*, etc., are found in the lower parts, but they are not a characteristic feature of this type; the mixture of hardwoods by single trees is rare. *Taxus baccata* often forms an under-storey. The principal associate vegetation in this type is:

Shrubs :—

Indigofera gerardiana,
Desmodium tiliaefolium,
Rosa macrophylla,
Deutzia corymbosa,
Lonicera angustifolia,
Viburnum nervosum,
Rubus niveus.

The shrub growth, however, is not heavy.

Weeds :—

Abundant—

Strobilanthes atropurpureus,
Impatiens gigantea,
Smilacina pallida,
Geranium wallichianum,
Ainsliaea aptera,
Polygonum amplexicaule,
Pteris aquilina.

Frequent—

Solidago virga-aurea,
Actaea spicata,
Thalictrum spp.,
Valeriana hardwickii,
Oxalis corniculata,
Trillium govanianum,
Senecio rufinervis,
Salvia glutinosa,
Galium rotundifolium,
Anaphalis nubigena.

Taxus baccata in the under-storey and weeds such as *Strobilanthes*, *Impatiens* and *Senecio* are the most difficult to deal with in this type. The slope is moderate to steep and the soil is generally rich, deep, cold and damp with a thick layer of humus in all stages of decomposition, sometimes as deep as 12″ to 18″. Grazing is not heavy except in the lower limits. Fires are unknown and the forests are difficult to burn except in exceptionally dry weather. Right-holders' demands for timber in this type is practically nil.

(*iii*) **The Abies-Picea-Pinus type.**—This type also occurs in the same altitudinal zone as type No. (*ii*). Silver fir of all age classes is found mixed with over-mature pine and spruce. Natural regeneration, both of pine and spruce, is entirely absent, and these species are being gradually ousted by silver fir. Consociations of blue pine are found on snow slides (Tosh Nal, Sharijani Thach), abandoned cultivation (lower slopes of Nakas and Kalga) and high pasture lands (Swajni, Shodo Bain, and Kalenchi Thaches in the Parbatti valley). The forests at the head of the Parbatti valley, *viz.*, Kalga, Nakas, parts of Bandag, Khirganga and Tosh Nal, are some examples of this type which is also extensively met with in Taranda and Pandrabis Ranges of Upper

Bashahr. In the Parbatti valley, this type is prevalent on the N. E. and N. W. aspects. It is entirely absent from the Beas valley. Hardwood glades do not generally occur in this type, but single trees such as *Acer* spp., *Taxus baccata, Corylus colurna*, etc., are found.

The principal associate vegetation is :—

Shrubs—

Rosa sericea,	*Viburnum foetens,*
Rosa macrophylla,	*Berberis vulgaris,*
Deutzia corymbosa,	*Pyrus lanata,*
Lonicera angustifolia,	*Spiraea bella,*
Indigofera gerardiana,	*Euonymus lacerus,*
Rubus niveus,	*Wikstroemia canescens,*
Salix elegans,	*Smilax vaginata,*

are occasionally met with, though not in thickets.

Weeds.—

Strobilanthes atropurpureus,	*Galium asperifolium* (?)
Impatiens gigantea,	*Podophyllum emodi,*
Smilacina pallida,	*Polygonum amplexicule,*
Ainsliaea aptera,	*Trillium govanianum,*
Valeriana hardwickii,	*Oxalis corniculata,*
Thalictrum neurocarpum (?)	*Anaphalis nubigena,*
Geranium wallichianum,	*Actaea spicata.*

The slope is moderate to steep. The soil is deep and fertile. The humus cover is thick generally varying from 3″ to 9″, but sometimes deeper. Grazing is not heavy. Sheep and goats graze in spring and autumn but not for long. There has been no fire in these forests for about 100 years when all the forests at the head of the Parbatti valley were burnt, as is borne out by the scorched bases and occluded fire wounds of mature trees of all three species in the overwood. There is practically no demand for timber by right-holders. The first extraction in forests of this type took place in 1915-16 when an attempt was made to put back the natural succession and regenerate these forests for a mixture rich in pine.

(*iv*) **The Abies-Picea-Cedrus type**.—This type occurs in Kulu and Seraj at the headwaters of the side valleys which are very steep and precipitous. The range of elevation is approximately 7,000′ to 9,500′. Bungdwari and Niaragahr in the Beas valley, Jel and Grahan Nal in the Parbatti, Niaragahr in the Hurla, Rolla in the Tirthan and the Girchis in the Kurpan valley are examples of this type of forest. On very steep and rocky slopes deodar of magnificent size is found pure ; on moderate to steep slopes, it occurs mixed with mature silver fir and spruce which in many cases have suppressed and even killed the deodar. Depressions and nala banks are colonized by hardwoods. The forests are wet and being inaccessible are naturally closed to grazing. They are difficult to burn and have perforce been rigidly fire protected at least for the last hundred years. Thick undergrowth of *Arundinaria* and *Strobilanthes* is a marked feature of these forests. Except for the removal by petty traders of a few hundred deodar trees from time to time, these forests remained untouched until 1919 when departmental exploitation started under the provision of the Revised Kulu Working Plan. They are still being worked mainly for deodar under the selection system.

(*v*) **The Abies-Betula-Quercus type.**—This is the highest level coniferous type and is outside the economic zone. Silver fir here is seen "dotted about" amongst birch (*Betula utilis*) and the high level oak (*Quercus semecarpifolia*). The conspicuous undergrowth is *Rhododendron campanulatum*, *Pyrus aucuparia* and in grass glades is found an alpine herbaceous flora. The growth of silver fir is stunted and the trees festooned with lichen. The fir generally regenerates under the hardwoods.

13. *Sub-types.*—It will be seen from the description of the associate vegetation in the above types that the ground flora overlaps in several cases which makes it difficult to base the primary classification of these forests on soil vegetation alone. The study of the ground vegetation is, however, of importance and value from the regeneration point of view. The following ten sub-types based on vegetation including shrubs and trees in the lower storey have been distinguished. As the treatment for regeneration in each sub-type varies, these sub-types may be taken as "treatment types":—

(*i*) Hardwood sub-type.
(*ii*) *Taxus* sub-type.
(*iii*) *Arundinaria* sub-type.
(*iv*) *Indigofera-Desmodium* sub-type.
(*v*) *Spiraea-Viburnum* sub-type.
(*vi*) *Plectranthus* sub-type.
(*vii*) *Strobilanthes*-balsam sub-type.
(*viii*) *Senecio* sub-type.
(*ix*) Bracken sub-type.
(*x*) *Iris* sub-type.

Each sub-type is briefly described below with special reference to the humus found therein, the presence and absence of regeneration and its probable cause and suggested remedy.

(*i*) **Hardwood sub-type.**—As already mentioned, both spruce and silver fir are very often found associated with broad-leaved trees such as *Aesculus indica*, *Juglans regia*, *Acer* spp., *Corylus colurna*, *Celtis australis*, *Machilus*, *Ulmus wallichiana*, *Alnus nitida*, *Populus ciliata*, *Prunus padus*, *Symplocos crataegoides*, etc., *e.g.*, Monalgarh 2/6 C. I (parts), Jaungi 2/23 C. I (parts), Parol 2/14 C. III (parts), Tosh Nal 2/3, C. IX (parts). This sub-type generally occurs in depressions and along *nala* banks. The associate vegetation is :—

Shrubs.—The shrub growth is sparse. The following shrubs are commonly found, but never in thickets :—

Viburnum nervosum,	*Spiraea sorbifolia*.
Rubus niveus.	*Salix elegans*.
Indigofera spp.	

Weed growth is not heavy except in those places where *Senecio*-cum-*Strobilanthes* cover the ground. The common weeds are :—

Senecio rufinervis.	*Smilacina pallida*.
Ainsliaea aptera.	*Polygonum amplexicaule*.
Oxalis corniculata.	*Solidago verga-aurea*.
Valeriana hardwickii.	*Pteris aquilina*.
Strobilanthes spp.	*Salvia gutinosa*.
Impatiens spp.	

Light conditions are good as several of the hardwoods in this sub-type are frequently lopped. The humus layer is thin, generally not more than 1 to 2 inches and

always well decomposed. Except under *Machilus*, where the soil is very cold and damp, regeneration both of spruce and silver fir is often very good, but does not make much headway as these areas are mostly frequented by cattle, sheep and goats. Simple closure coupled with lopping should establish the regeneration in this sub-type.

(*ii*) **Taxus sub-type.**—In the *Abies-Picea* main type, areas are met with where *Taxus baccata* forms an under-storey to mature and over-mature spruce and silver fir. This sub-type is confined to sheltered depressions on cool northern slopes and is a climax type. Examples are Tosh Nal 2/3, C. VII (parts), Kalga 1/6, C. II (parts), etc. The associate vegetation in this sub-type is :—

Shrubs.—The cover of the overwood combined with that of the underwood is dense and dark. Stunted *Deutzia corymbosa, Lonicera angustifolia, Rosa macrophylla, Indigofera gerardiana* and *Viburnum nervosum* are found but never in thickets. *Deutzi, corymbosa* and *Lonicera angustifolia* are the characteristic shrubs in this sub-type.

Weeds.—Strobilanthes wallichii, Smilacina pallida, Trillium govanianum are abundant, while *Galium rotundifolium, Podophyllum emodi, Smilax vaginata* and ferns are frequently met with.

The soil is damp and cold, accumulation of humus is fairly heavy and regeneration is conspicuous by its absence.

Drastic opening of the canopy followed by cutting of yew, raking up of the humus and a *hot* burn in a good seed year is indicated. No bushes and hardwoods should be cut, rather they should be encouraged. Grazing is beneficial as a preliminary and closure should be enforced only after a good seed fall.

(*iii*) **Arundinaria sub-type.**—Both *Arundinaria falcata* and *Arundinaria spathiflora* form impenetrable thickets in forest of *Abies-Picea-Cedrus* type. This is the climax type of undergrowth in regions of heavy rainfall. Niaragahr and Rajgiri forests in the Mohalkhad, Niaragahr and several other forests in the Hurla and the Girchis in the Kurpan valley are good examples of this sub-type. The forests are moist, the humus accumulations heavy, grazing is usually absent and undergrowth, both of bamboos and *Strobilanthes* is consequently impenetrable. Natural regeneration of any of the tree species is virtually impossible without bold intervention on he part of the forester.

Both bamboos and *Strobilanthes* die when they flower and if drastic steps are then taken, these plants can be considerably reduced. In the Hurla valley, after partial removal of the overwood, cutting and burning of *nirgal* and *Strobilanthes* followed by sowing and planting have been done with encouraging results. Fire and grazing, as aids to natural regeneration in this sub-type, are indicated, but effective grazing is impracticable owing to remoteness of the locality.

(*iv*) **Indigofera-Desmodium sub-type.**—This sub-type occurs mostly in the *Picea-Pinus-Cedrus type*, pure or associated with bracken. There is ordinarily no difficulty as regards regeneration of spruce and silver fir in this sub-type provided the undergrowth does not form thickets. The sub-type indicates well drained and well aerated soil conditions.

In Bajraundi 1/1, C. VI (parts), this sub-type occurs and under it profuse regeneration of well-established spruce exists. In the sparsely stocked *Indigofera*-cum-*Desmodium*-cum-bracken sub-type, the depth of humus is up to 1″ and spruce fir regeneration is good ; under thickets, humus is generally 4″ to 6″ and both spruce and silver fir regeneration is entirely absent. In this sub-type, the canopy may be opened up fairly heavily ; bushes should not be cut unless they form thickets and the *débris* if not removed by villagers, be collected in small heaps and burnt only if bushes have to be cut and burnt. Over thickets of undergrowth, the canopy should be opened up rather cautiously. Closure to grazing and removal of litter should be enforced in a good seed year.

(*v*) **Spiraea-Viburnum sub-type.**—In this sub-type the undergrowth is mainly composed of *Spiraea lindleyana, Viburnum nervosum*, pure or associated with bracken fern or *Iris. Salvia glutinosa* is also sometimes found growing scattered under them. Jaungi 223, C. I. (parts). Parol 2/24, C. III (parts) and Marhaun 2/26, C. I. belong to this sub-type. It is a sub-type met with in pure belts of spruce in the *Picea-Pinus-Cedrus* main type, it does not occur in forests of the *Abies* type. This sub-type shows moist soil conditions, generally unsuitable for regeneration. The humus layer is 2″ to 4″ deep and spruce regeneration is absent except where moderate grazing is exercised and litter is removed (Marhaun 2/26 and Parol 2/24). In heavily grazed areas, these bushes give cover to the germinating seedlings.

In this sub-type, the canopy should be opened moderately. The bushes should be cut wherever they form thickets and burnt hot together with *débris* on cut over areas in order to kill the root stocks of the undergrowth. Closures should be enforced in a good seed year.

(*vi*) **Plectranthus rugosus sub-type.**—In pure spruce forests, especially in those which are heavily grazed, *Plectranthus rugosus* often forms colonies, *e.g.*, parts of Bajraundi 1/1, C. I. This sub-type shows dry and compact soil conditions and deterioration in the factors of the locality due to the action of man. The humus layer is almost absent in heavily grazed areas and about 3″ to 4″ deep in closed areas. Spruce regeneration is entirely absent in areas both open and closed to grazing. An amelioration of the factors of the locality must take place before regeneration can be expected.

(*vii*) **Senecio sub-type.**—*Senecio rufinervis* often forms a dense ground cover, pure or associated with *Ainsliaea aptera* and *Strobilanthes atropurpureus*, the former on warmer aspects and the latter on colder slopes, *e.g.*, Bajraundi 1/1, C. I. (upper parts) and Monalgahr 2/6, C. I. (parts). This sub-type is conspicuous in the rains and autumn. *Senecio rufinervis* has matted root system, often 1½ feet deep, and both spruce and silver fir regeneration is absent (Bajraundi 1/1, C. VI and Monalgahr 2/26 C. I.). At present recommendations regarding this type cannot be made.

(*viii*) **Bracken sub-type.**—Bracken forms extensive colonies in open places both at low and high levels. It is also associated with *Indigofera-Desmodium* and *Spiraea Viburnum* sub-types, *e.g.*, Jaungi 2/23, C. I., Parol 2/24, C. I., Marhaun 2/26, C. I. "This fern appears and multiplies vegetatively at a rapid rate by means of rhizomes and produces a matted mass of root stock." In thick colonies the humus layer is up to

10″ deep and regeneration is absent due to the combined effect of humus and shade (Monalgahr 2/6, I. C.). Under these circumstances only planting is likely to succeed. In the *Indigofera-Desmodium*-bracken association, the bracken is not vigorous, the humus is thin and spruce regeneration good (Bajraundi 1/1, C. VI). In the *Spiraea lindleyana-Viburnum nervosum*-Bracken association, the humus layer is 2″ to 3″ deep and regeneration is present, though scanty (Jaungi 2/23, C. I.). In a heavily grazed bracken-*Salvia glutinosa* association, there is no humus and the regeneration of spruce is good (Jaungi 2/23, C. I.).

(*ix*) **Iris sub-type.**—*Iris nepalensis* often forms extensive colonies in the *Picea-Pinus-Cedrus* type. It carpets the ground, sometimes *Viburnum nervosum* and *Spiraea lindleyana* growing thinly over it, *e.g.*, Jaungi 2/23, C.I. (parts) and sometime *Indigofera gerardiana* and *Desmodium tiliaefolium*, *e.g.*, Dudhlu 1/4 (parts). The latter association does not show such moist conditions as the former. *Iris* has a matted root system and generally produces humus ½″ to 2″ deep which inhibits regeneration (Takrasi and Kalandi Dhar in Outer Seraj and Jaungi 2/23, C. I. in Kulu). At lower elevations and where associated with *Indigofera gerardiana* and *Desmodium tiliaefolium* spruce, pine and deodar regeneration does come in, though gradually.

A heavy opening of the canopy, stubbing out of *Iris* in patches and burning are indicated. The shrub growth should be retained and closure to grazing enforced.

(*x*) **Strobilanthes-Balsam sub-type.**—*Strobilanthes atropurpureus*, *Strobilanthes wallichii*, *Impatiens gigantiea* and *Impatiens amplexicaulis* are pestilent weeds in all forests of the *Abies* type lying between 8,000 and 9,500 feet. They grow tall and thick and produce heavy deposits of black acid humus, dry in summer and autumn, and wet and cold in spring and the rains. The humus layer is thin (3″ to 4″) in the open, on steep slopes and in areas where it is overgrown with *Indigofera gerardiana* ; in depressions and on moderate slopes it is often as thick as 12″ to 18″. *Strobilanthes*, a perennial, has a massive root system which it is difficult to pull out, but the balsams are annuals and can be pulled up easily. On burnt patches, balsams come up to the exclusion of other weeds and are easily dealt with.

These weeds inhibit regeneration where they form colonies by themselves, but very good natural regeneration of silver fir has been observed where their growth is sparse and where they are overgrown with shrubs and hardwoods such as *Indigofera gerardiana*, *Corylus colurna*, *Acer* spp. *Prunus padus*, etc. (Pulga R/1 and Kalga 1/6, C. I., Sect. 1).

It is well-known that *Strobilanthes atropurpureus* and *Strobilanthes wallichii* flower after an interval of years and then die, but a new crop comes up readily from seed the very next year and the pest is soon as bad as ever. The best way to exterminate it is to cut off the flower bearing shoots just before the seed is ripe, *i.e.*, towards the end of the rains. This has been done on an extensive scale in Jaunsar in 1918 and 1930 with excellent results.

Strobilanthes is reported to have flowered, at least is some parts of Kulu, in 1927. A circular letter has recently been issued by the Conservator of Forests, Eastern Circle, anticipating flowering of *Strobilanthes atropurpureus* in 1933-34. At the instance of

the author, *Strobilanthes*-bearing areas were surveyed in Bashahr, Seraj, Kulu and Kangra Divisions in 1931, and their exact situation is now known.

The following recommendations based on experience gained in Jaunsar on the 1918 and 1930 work should be helpful :—

1. Make adequate labour arrangements beforehand.
2. Start work in the middle of July and continue until the end of August.
3. Plants should be cut down as close to the ground as possible.
4. The cut plants should be collected in heaps.
5. Work should be started in the areas which flower earlier.
6. Second crop of flowers, appearing on the coppice before the end of August, must be destroyed.
7. Flowers appearing in September should be ignored.

According to Mr. Parker (*vide* his letter No. 1432, dated 24th January 1933) the flowering of this species (*Strobilanthes atropurpureus*) is spread over two years separated by an interval of 12 years, but it is not known whether every plant in a given area flowers in the same year and every plant in another area in the following year, or whether some plants in an area flower one year and the remaining plants in the same area in the following year. The work should, therefore, be carried out in both the years and any seedlings appearing the following rains should be pulled up.

The other possible methods of its eradication are :—

1. Grubbing out ; but in this method results are not commensurate with the expenditure, except in patches to be sown or planted, where after pulling out, the plants should be burnt hot.
2. To combine eradication with cultural operations.
3. To combine eradication with field crops.
4. After being trodden down by sheep and goats, cutting and burning hot.

Last year, as a result of early snowfall (November 1932), *Strobilanthes* in Pulga, Nakas and Kalga forests in the Parbatti valley, became a dead and dry mass through which a fire was run successfully. In Kangra, *Strobilanthes* was burnt hot twice over 10 acres in the beginning of 1932, but is reported to have regrown with more vigour than before. It is, however, believed that repeated firing and heavy sheep and goat grazing would weaken the vitality of *Strobilanthes* and eventually facilitate its uprooting.

The following experiments on the treatment of *Strobilanthes* so as to induce natural regeneration have been started and results are being watched :—

(1) Disturbing the humus and plant root system by grubbing ;
(2) Grubbing out and burning hot ;
(3) Grubbing out, burning and raising of field crops ; and
(4) Repeated burning of the forest floor until a good seed year.

14. *Ecology and Silviculture of spruce and silver fir seedlings.*—This subject has been dealt with in some detail in paragraphs 6 and 7 of the paper "Silviculture and Rengeneration of the Himalayan spruce and silver fir" by Messrs. Parma Nand and Wright presented to the 1922 Punjab Forest Conference. It need not, therefore, be

repeated here. Briefly, both spruce and silver fir shed their seed during October and November. The spruce seed is very small, 0·15 to 0·20 inch long; silver fir seed is bigger, being about 0·5 to 0·6 inch long. The seed lies dormant under the snow till the spring, when silver fir begins to germinate in April and continues to do so to the end of May. Spruce having a harder coat, commences to germinate much later and the germination is not complete until the middle of August. Germination requirements of the two species seem, therefore, to be different, spruce requiring more heat and moisture than fir. Silver fir should, therefore, be sown in autumn and spruce in June-July.

Both spruce and silver fir germinate under all conditions of light and shade, on all kinds of soil with various amounts of humus and even on decaying wood, in fact, everywhere where sufficient heat and moisture are obtainable. The establishment of regeneration is, however, quite a different matter to germination. If the seedlings are to survive and to develop, a clean seed bed, plenty of light, and a sufficiency of moisture are essential. *Excessively damp localities, heavy accumulations of humus,* stiff soils, heavy cover of trees, bushes or weeds are not suitable for the successful development of these conifers. On the other hand they do not mind and in fact, welcome, a light cover of hardwoods and shrubs. Silver fir does tolerate shade in the seedling stage, and will continue to live under shade for a long period, but for growth and development it is considered to need as much light as spruce. As much as 12″ to 18″ annual shoots have been measured in the open, as opposed to only 2″ to 3″ under the close cover of the mother trees. The following table gives the seedling heights of both spruce and silver fir based on a number of measurements made under thin to dense canopy :—

Species.	Height Classes.							
	1″—6″	7″—12″	13″—18″	19″—24″	25″—30″	31″—36″	37″—42″	43″—48″
	Age in years.							
Spruce	1	3	4	5	5	6	6	7
Silver fir	2	5	7	9	10	12	13	15

15. *Factors influencing regeneration.*—Reference is again invited to paragraphs 7 and 9 of the above quoted paper, where observations regarding existing spruce and silver fir regeneration and probable causes of the failure of regeneration are detailed. In the course of further inspection of the Kulu forests in connection with this study, it has been observed that abundant natural regeneration of both spruce and silver fir exists :—

(1) where the mineral soil has been exposed either naturally through landslips and snowslides or artificially through roadside cuttings, scraping of litter, removal of felling refuse and humus (by burning or otherwise), or hoeing the ground in patches,

(2) where the underlying soil is sandy, pebbly or stony,

(3) where the shrub and weed growth are scanty either because of excessive grazing or medium overwood cover,

(4) where the undergrowth consists of scattered bushes of *Indigofera gerardiana*, *Desmodium tiliaefolium*, or *Viburnum nervosum*,

(5) where the underwood is composed of an open forest of hardwoods such as *Aesculus indica*, *Acer* spp., *Corylus colurna*, *Alnus nitida*, *Ulmus wallichiana*, *Symplocos cratægoides*, *Prunus padus*, *etc.*,

(6) where the ground is sloping and well drained,

(7) where the canopy is naturally broken, either in small narrow strips or in small patches, or where it has been artificially, but moderately, opened out, and

(8) On rotting logs and decaying wood.

Profuse natural regeneration of silver fir with a fair mixture of both spruce and pine has been obtained in Pulga, Kalga and Nakas blocks of forests (Parbatti Valley, Kulu), felled over under the uniform system in 1915-16 to 1917-18, where *débris* and humus were burnt, soil was worked and closure to grazing enforced.

The factors inimical to natural regeneration of both spruce and silver fir, therefore, seem to be—

(1) Heavy accumulations of humus.

(2) Accumulations of felling refuse.

(3) Thicket growth of weeds or shrubs.

(4) Heavy opening of the canopy either under shelterwood or in gaps or in strips.

(5) Infrequency of prolific seed years.

(6) Heavy uncontrolled grazing.

(7) Bad drainage.

The following table which summarises the average depth of humus in several vegetative sub-types and its relation with natural spruce and silver fir regeneration will be of interest :—

Type of vegetation.	Depth of humus.	State of natural regeneration.	Locality.
(*i*) SPRUCE FOREST.			
1. *Indigofera gerardiana*-cum-*Desmodium tiliaefolium*-cum-bracken fern.	Up to 1″	Good spruce fir regeneration.	Bajraundi 1/1, C. VI, E. Plot 32, closed to grazing.
2. Bracken fern-cum-*Salvia glutinosa* (heavily grazed over).	*Nil*	Good regeneration.	Jaungi 2/23, C. I, E. Plot 33.
3. *Viburnum nervosum*-cum-*Salvia glutinosa*-cum-*karash* grass, grazed over.	3″—4″	Good spruce regeneration.	Parol 2/24, C. III, E. Plot 38.
4. *Viburnum nervosum*-cum-*Spirae lindleyana*-cum-bracken fern, grazed over	2″—3″	Scanty regeneration.	Jaungi 2/23, C. I, E. Plot 34.

Type of vegetation.	Depth of humus.	State of natural regeneration.	Locality.
	(*i*) SPRUCE FOREST—*concld.*		
5. No undergrowth ; *Suhar* (litter) removed by right-holders and area grazed over.	*Nil*	Sufficient regeneration but poorly grown.	Jaungi 2/23, C. I., E. Plot 35.
6. *Plectranthus rugosus* ..	3″—4″	No spruce fir regeneration.	Bajraundi 1/1, C. VI, E. Plot 32, closed to grazing.
7. Thick growth of *Rubus niveus* (on burnt area).	4″—12″ (roots up to 2′ deep).	Ditto.	Ditto.
8. *Iris nepalensis* ..	1½″—2″	No spruce regeneration.	Jaungi 2/23, C. I., E. Plot 36 (the area is grazed).
9. *Senecio rufinervis* (*dhura*) ..	2″—4″ (roots up to 1½′ deep).	No spruce fir regeneration.	Bajraundi 1/1, C. VI., E. Plot 32, closed to grazing.
10. Dense bracken fern ..	10″	No spruce regeneration.	Monalgahr 2/26, C. I., E. Plot 30, closed to grazing.
11. Dense undergrowth of balsam spp. ..	2″	Ditto ..	Monalgahr 2/26, C. I., E. Plot 30, closed to grazing.
12. Dense undergrowth of *Spiraea sorbifolia.*	4″	Ditto ..	Monalgahr 2/6 C. I, E. Plot 30, closed to grazing.
13. Dense undergrowth of *Strobilanthes* spp.	4″	Ditto ..	Ditto
	(*ii*) SILVER FIR FOREST (CLOSED TO GRAZING).		
1. Sparse undergrowth of *Indigofera gerardiana.*	2″—3″	Good silver fir regeneration.	Kalga 1/6 C. I. Sec. 4, (E. P. 18).
2. Thick undergrowth of *Indigofera gerardiana* and *Rosa macrophylla.*	4″—6″	No regeneration	Ditto.
3. Bushy coppice growth of *Acer* spp. and *Prunus padus.*	5″—6″	Ditto ..	Kalga 1/6 C. I. Sec. 1 (E. P. 14).
4. *Acer pictum—corylus colurna* in tree form.	1″—2″	Very good silver fir regeneration.	Kalga 1/6 C. 1. Sec. 1 (E. P. 14.)
5. Sparse undergrowth of *Indigofera gerardiana* and *Strobilanthes atropurpureus.*	1″—2″	Very good natural regeneration of silver fir.	Pulga R/1., E. Plot 13.
6. Thick undergrowth of *Strobilanthes atropurpureus.*	3″—4″	No regeneration..	Ditto.

III.—EXPERIMENTAL RESEARCH IN THE REGENERATION OF SPRUCE AND SILVER FIR.

16. *Experiments carried out prior to* 1931—(*i*) The first attempt in the experimental study of the natural regeneration of close canopied mature and over-mature spruce was made in 1914, when Troup laid out 4 sub-plots of about 0·4 acre each at Jabaldar Dhar in compartment 154-E., Nogli Range, Lower Bashahr Division, at about 7,000 feet. The ground flora consisted of light shrubby undergrowth and dense *Strobilanthes* with *Ainsliaea aptera* ferns and some *Iris*. In sub-plots (*a*), (*b*) and (*c*) a very heavy seeding felling (seed bearers about 100 feet apart) was made, removing all over-mature spruce and silver fir and all hardwoods to admit abundance of light. In sub-plot (*a*) all undergrowth was cut and burnt along with *débris*; in sub-plots (*b*) and (*c*) undergrowth was not cut and *débris* were left unburnt. Sub-plot (*d*) was an unfelled and untreated control. Sub-plots (*a*), (*b*) and (*d*) were fenced against grazing while sub-plot (*c*) was left open.

In April 1926, in sub-plot (*a*) 8 spruce and 10 silver fir, in sub-plot (*b*) 27 spruce and 2 silver fir, in sub-plot (*c*) 4 spruce and no silver fir and in sub-plot (*d*) no seedlings were counted, but it was noticed that the majority of the seedlings was older than 1914, (no initial record was kept) and that the few seedlings that came up since were either centered round the mother trees left in the plots, or were growing in the upper line of the sub-plots immediately below the unfelled forest. As regards undergrowth, practically no difference was found between sub-plots (*a*) and (*b*) except that in the latter, coarse grass was coming up. In sub-plot (*c*) there was practically no undergrowth except dense groups of *Litsea* and *Sarcococca pruniformis*, which had escaped the cattle, sheep and goats. Humus layer was still very thick in sub-plot (*d*) (about 1 to 1½ foot) and to some extent in (*c*), while there was practically no humus cover in sub-plots (*a*) and (*b*).

The experiment, as it stands, shows tentatively that—

(1) in a close canopied crop where thick humus layer is not removed, closure to grazing alone does not induce natural regeneration ;

(2) heavy seeding fellings without removal of raw humus, undergrowth, and felling refuse do not induce natural regeneration without closure to grazing ;

(3) heavy opening of the canopy, with or without cutting of undergrowth and *débris* burning, does decompose heavy accumulations of humus ; and that closure to grazing, even without brushwood cutting and *débris* burning, induces regeneration but to a very small extent.

The above experiments, however, cannot be considered conclusive, as in them initial comparability as regards overwood, initial count of seedlings and strict enforcement of closure or non-closure to grazing were wanting. The areas taken up for investigation were, moreover, too small to give any definite results so far as regeneration investigation goes.

(*ii*) A similar experiment was started in 1914 by Troup in a mixed forest of spruce and silver fir, the latter predominating, in Deoban, Chakrata Division, United Provinces, at an elevation of 8,300′, northern aspect, moderate slope. A heavy seeding felling was carried out in four sub-plots of about an acre each. In the spring of 1915, dense undergrowth of *ringal* and other shrubs and herbs was cut and the *débris* burnt in sub-plots (*b*) and (*d*) but not in (*a*) and (*c*) and all sub-plots were fenced against grazing in October 1915. 1916 was a good seed year, and before seedfall, half of each sub-

plot was hoed up to a depth of 4" to 6", and in sub-plots (*a*) and (*d*) undergrowth was again cut back. In October 1917, there was scarcely a seedling of spruce or silver fir in any of the sub-plots ; the undergrowth, however, was very dense including *Strobilanthes*, though less in hoed areas. No regeneration was noticed in 1920 and 1924, when the undergrowth was still dense, and in parts of the area, herbaceous growth was being replaced by *Rubus* spp.

The conclusions are that in this type of spruce and silver fir forest, heavy opening of the canopy results in heavy weed growth which prevents all natural regeneration.

(*iii*) In compliance with the recommendations of the 1922 Punjab Forest Conference the following experimental plots were laid out in Lower Bashahr Division in 1923, separately in spruce and silver fir forests, to study their natural and artificial regeneration :—

(1) Heavy and medium shelterwood regeneration fellings,
- (*a*) with *débris* burning and fencing,
- (*b*) with *débris* burning only,
- (*c*) with no subsequent operations,
- (*d*) all operations combined with sowings.

(2) Clear fellings with the same operations, as mentioned above, in two cases combined with field crops, spruce and silver fir seed being sown after harvesting the crops.

1927 was a good seed year for both spruce and silver fir. The silver fir experiments have given entirely negative results, while in the case of spruce fir plots, a very small amount of regeneration appeared in small patches where *debris* was burnt and where heavy shelterwood fellings were carried out. In the absence of light shelterwood fellings, however, no conclusions can be drawn from these experiments.

(*iv*) In Kalga and Nakas forest blocks (Parbatti Valley, Kulu), extensive areas in the *Abies-Picea-Pinus* type were felled for the first time under the uniform system in 1915-16 to 1917-18 by Trevor. The canopy was moderately opened, 25 to 30 feet, at high levels and 40 to 55 feet elsewhere. After fellings humus and *débris* were burnt and the area closed to grazing. Since fellings, there have been at least three good seed years for spruce and silver fir and more for blue pine ; in the lower limits, deodar was introduced artificially. Natural regeneration was constantly weeded and brushwood cutting done, where it formed thickets. These areas may be considered as large scale experiments in the regeneration of both spruce and silver fir. Secondary fellings were made in 1927 and the areas are now almost completely regenerated with a mixture of silver fir, spruce and blue pine. Kalga 1/6, C. I., section 4, is an ideal example in the regeneration of these forests and nothing better could be desired. The change in soil conditions due to fellings in the canopy is shown by the fact that pine is still regenerating.

(*v*) Molagthana 1/42, C. I. (Lower Kulu), a forest of the *Picea-Cedrus-Pinus* type, with a fair proportion of mature silver fir in the overwood, was felled over in 1915-16 under the uniform system, keeping the mother trees about 40 to 50 feet apart. The humus and *débris* were burnt and the area closed to grazing. Deodar was artificially introduced. The area is now fairly well regenerated with a mixture of all the four conifers. This large scale experiment in the natural regeneration of this type of forest has been a complete success, but the process is a slow one and after 15 years the regeneration is only 3-4 feet high.

(*vi*) Bajraundi 1/1, C. VI., Upper Kulu, a forest of *Picea-Cedrus* type, with silver fir in its upper limits, was felled over in 1918-19 under the uniform system, mother trees spaced 40 to 50 feet in lower elevations and 30 to 40 feet higher up. The usual cultural operations were carried out and now about 2/3rd of the area is a magnificent sight with profuse well-established natural regeneration of both spruce and deodar. Secondary fellings were carried out some six years ago and the forest is now much richer in deodar than it originally was.

(*vii*) In Hathipur 2/60, C. I. and Jaung R/7, C. I. (Lower Kulu elevation 8,000′ to 9,000′), strips 125, 150, 180 and 200 feet wide alternating with unfelled strips of varying widths running N. E. to S. W. were clear-felled in 1921-22. The *débris* was burnt, but closure was not rigidly enforced. Little regeneration has come up, but the felled strips are clear of humus and the undergrowth has been browsed down to the ground. Closure has now been enforced and with the prolific seed fall in October-November 1932, it is hoped that some tangible results will follow. These areas have now been constituted into experimental plots of the Silvicultural Research Division.

(*viii*) About 30 acres of mature and over-mature spruce and silver fir forest of the *Abies-Picea* type in Monalgahr 2/6, C. I., 8,300′ to 8,800′ with east to north-eastern aspect were clear-felled and logged, in 1921-22. The felling refuse was burnt but the humus was not removed ; the area was closed to grazing. This resulted in a heavy weed growth of balsam, bracken, *Strobilanthes*, *Senecio*, with *Indigofera* on spurs and *Spiraea lindleyana* in depressions. The area was again opened to grazing of cattle, sheep and goats in 1927 and remained open until 1931 when it was again closed. There was no regeneration on the ground, but the humus layer had entirely disappeared and the weed growth was not so formidable as in 1927, due, of course, to continuous exposure and excessive grazing. The ecological conditions have entirely changed, as is apparent from the ground flora now existing. This area has since been taken over by the Silvicultural Research Division and is being restocked artificially with a mixture in groups of silver fir, spruce, *kail* and deodar.

(*ix*) The lower parts of Kangni 2/1, C. I., Sanchalshil 2/24, C. I., Patalsu 2/10, C. II, and Mati Ban 2/12, C. III, pure spruce and silver fir forests at the head of the Beas valley have the appearance of a heavy seeding felling, and have been so for a considerable time. They have been heavily grazed over by both cattle, sheep and goats. There is not a seedling on the ground, but exposure and heavy grazing have produced soil conditions most suitable for natural regeneration—there is practically no humus and little undergrowth. 1932 was a prolific seed year for spruce and abundant seed has fallen on these areas. About 50 acres of Kangni 2/1, C. I., are now being effectively fenced against grazing of all kinds, and it is to be seen if closure after a good seed-fall in such areas results in regeneration.

17. *Experiments now in progress.*—A very large number of experiments on the manipulation of canopy, underwood, shrub and weed-growth, exploitation, *débris*, humus, soil, grazing and fire, laid out in consultation with the Forest Research Institute, have now been initiated covering all aspects of the problem of the growth, reproduction and development of these trees. It would be tedious to give details of all this work and results from them need not be expected for some years. It has, however, been shown in this paper that natural regeneration has been obtained in quantity by a deliberate regeneration felling and that over considerable areas of decadent forest simple closure is likely to do all that is required. It is hoped that all officers will take an increased interest in the silvicultural problems of these species.

In conclusion the author wishes to acknowledge the very valuable advice and help of Messrs. Trevor and Champion and the assistance in the field of F. R. Khan Sultan Mohammad Khan.

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PLANTATION *VERSUS* RETRENCHMENT.

Some years ago we were all being taught, or were telling others, about the imminent world timber famine; the one aim and object of every trained forester was to produce more and more trees which would produce the necessary timber to meet such a world shortage. Since then timber has to some extent lost its position as the prime necessity in any building or development scheme, be it houses, factories, bridges or ships. Steel and concrete have displaced timber from its position as the leading building material in many of the markets of the world so that in countries where forestry finds a place in the public press its exponents have turned gradually from the needs of timber production to the other arguments which justify forestry, namely, flood control, water conservation, erosion, game preservation, national parks and recreation.

In India however we still have a great and almost undeveloped field for increasing the uses of wood. As living conditions improve with the spread of education the villager as well as the town dweller will find a need for larger houses and better furniture than have satisfied him in the past. The use of timber as a structural material may have been superseded to some extent in the larger cities, but provided Government and the Forest Department is satisfied with a small profit on a large turnover, there are many good reasons why the villager should continue to use the local timber for most of his needs both for structural work such as beams, poles, planks, frames and slabs and for all the usual articles of furniture in his simple home. Whenever teak and *sal* are plentiful it is unlikely that the villager will give up using these splendid timbers. Where the main supply is of less satisfactory

or less durable timbers some practical demonstrations of the value of preservative treatment, provided this could be applied on the spot, would soon convince him that "there is nothing like wood."

In face of this intrinsically sound position of wood as a staple Indian industry and in view of our responsibilities as the managers of a major industry which provides employment to countless thousands of the rural population, we as wood producers should insist upon the carrying out of whatever regeneration and plantation work is necessary to guarantee the maintenance of the forests and so included in working plans or previously sanctioned by Government. There is a tendency in almost every province and state to find "savings" by curtailing work on sanctioned regeneration work. This tendency must be fought down if posterity is ever to reap the benefit of the careful years of conservation and improvement which have been devoted to the Indian forest estate by the older generation of forest officers.

Much as the conservative Britisher may object to the American accent, there is no doubt that we have a great deal to learn from the western method of dealing promptly and firmly with situations as they arise. The United States are making a magnificent effort to cope with their problems of money, supply, production and employment, and we as foresters cannot fail to be impressed with President Roosevelt's plans to cope with unemployment by an intensive development of forest work. A beginning has already been made to employ an army of men "in the construction, maintenance and carrying on of works of a public nature in connection with the forestation of lands belonging to the United States or to the several states which are suitable for timber production, the prevention of forest fires, floods and soil erosion, plant pest and disease control, the construction, maintenance and repair of paths, trails and fire-lines in the national parks and national forests and such other work on the public domain and government reservations as the President may determine to be desirable."

The Forest Service has accordingly mapped out a 10 years' programme to deal with this unexpected development, under which they hope to accomplish as much as would take 50 years with their normal budget grant. They are prepared to find employment for 250,000

men in the national forests alone, and the congressional measure visualises an extension of this work to municipal and private forests as well. The work in the national forests will include the stringing of telephone lines, building minor roads and trails, landing-fields, fire-breaks, lookout towers, range fences, wells and water tanks, improvements at public camp sites and many activities related to insect and blister rust control and improved silviculture.

In Italy also the great effort towards efficient land planning which has already accomplished much useful work under the *bonifica integrale* has afforestation as one of its main features. It is a national undertaking in land improvement which includes the control of mountain streams, the checking of soil erosion by afforesting bare slopes, the draining of swamps many of which are now being planted up and the reclamation of idle lands which have gone out of cultivation, besides much engineering work in the building of roads and reservoirs. Under this plan Italy is to spend about 120 crores of rupees in the next 14 years.

Let us compare these great national forestry efforts with what is happening in India and Burma. Every forest officer and timber man we meet fills us with a deeper gloom than the last, and the reviewing of annual reports becomes a funereal dirge. Many Indian forest officers and particularly some in Burma, appear to be losing their *esprit de corps* through an over-dose of self-depreciation, an inferiority complex which has developed in the thought of the growers of wood from the dawning consciousness that wood is no longer the undisputed leader amongst raw materials in the structural and building markets of the world.

The realisation of this hard fact comes as an unpleasant shock to both the growers and sellers of wood, who see their old markets shrinking in face of the concentrated attack of the manufacturers of wood-substitutes—concrete, steel and aluminium in structural work and fuels, textiles, rubber and synthetic products in the other markets for wood. The secret of success in the case of these other products lies in two words,—*research* and *publicity*. It is through research that concrete, steel and the newer metals have found fresh uses and fresh adaptations

and it is through carefully organised publicity that these materials are being planted upon the markets of the world in ever-increasing quantities. What on the other hand has been done by wood producers to maintain their place in the sun? There are now four great forest products research stations in the world, namely Madison, Ottawa, Princes Risborough and Dehra Dun and between them they have produced notable results in increasing our common stock of knowled of timber, accurate strength tables, better seasoning methods, new preservative treatments and developments in plywood, veneer, parquet flooring, wood pulp production, and the successful introduction of many new tropical woods into the furniture market. Timber research has therefore not been entirely neglected, and we must look beyond the research stage for the cause of the admittedly depressing condition of our local timber markets in India and Burma. Have these research results been appreciated by forest officers or applied on any large scale by the timber trade? Have any of the larger timber firms or timber trade organisations in India or Burma taken active steps to apply these research results towards greater trade development or in recapturing some of the ground lost in their old markets?

Compared with the widespread activities of such organisations as the Concrete Association of India with its pamphlets and lavishly illustrated monthly magazine for encouraging and utilising research developments, the Indian timber trade as a body appears to be singularly lacking in enterprise both as regards applying research results and in educating the public in the uses of wood. We would therefore suggest that a beginning be made in effecting better co-operation between individual forest officers and the local timber traders, so that the work of the Forest Research Institute may be brought to their notice and a beginning made in the better advertising of local timbers. In this way the forest estate of which we are the trustees will become more fully and efficiently utilised. The launching of vast afforestation schemes such as the American and Italian ones is not the only way in which we may work towards the furtherance of a forestry ideal. There are others less expensive and less spectacular and probably more suited to the true welfare of this country, but

we would impress upon our readers the prime necessity of realising and getting others to realise that progressive and scientific forestry is a very vital link in India's full development.

STATISTICS AND THEIR VALUE IN FOREST POLICY.

By Sir H. W. A. Watson.

With most other commercial activities the timber trade of the world is experiencing a most difficult time and forestry suffers with the timber trade through the tendency that exists to judge its activities from the purely commercial standpoint. A main precept however that forestry teaches is to look ahead and on the outlook ahead there should be no grounds for discouragement. Apart from the admitted benefits which forests confer, there will always be a steady demand for timber. As we cannot foresee the future we can only base our judgment on statistics of the past.

The relative size and timber markets of the United Kingdom of Great Britain and Northern Ireland compare with those of the Indian Empire as follows :—

	Area square miles.	Population (millions)	Approximate annual volume of trade in unmanufactured timber, millions of tons of 50 c. ft.	
United Kingdom..	94,000	45	10·6	Largely converted timber : average annual imports 1928-30 + home production.
Indian Empire ..	1,805,000	350	2·3	Round timber average of 3 years ending 1929-30.

The United Kingdom neglected its forests in the past and as a result now has to import some 10 million tons of timber annually.

The whole trade extraction of the Indian Empire, continental in size and containing about one-fifth of the human population of the world, is only about two million tons of round timber or in terms of converted timber about 1/10th of the quantity of timber that the United Kingdom requires and has to import.

That the timber trade of India is so comparatively small is due to the fact that there are still large areas of forest from which the local inhabitants have from time immemorial extracted their requirements without the necessity for trade intervention. This state of affairs, however, cannot last for ever. The forests are steadily receding before the pressure of increasing population and as they recede the people living beyond their fringes must rely on traders to supply their requirements in timber and forest produce.

Moreover, the incidence of the area classed as forest varies in each province, from about 2 per cent. in the North-West Frontier Province to about 67 per cent. in Burma. As a result there is a very considerable trade in timber between some of the provinces and notably from the heavily forested province of Burma to India. Burma alone is responsible for roughly half the trade output of timber in the Indian Empire and roughly one-fourth of this output is composed of Burma teak.

Excluding Burma, India imports considerable quantities of timber. So far as the statistics go, the average annual imports to India *excluding* Burma during the three years ending 1929-30 in thousands of tons were as follows :—

From Burma	..	204, largely teak.
From elsewhere	..	25 including 11 thousand tons of teak mainly from Siam and Indo-China.
Total	..	229 thousand tons of converted timber,

excluding large quantities of railway sleepers for which no figures are available.

The figures exclude also large quantities of foreign timber shown by value only in the Returns, the value of which during the three years ending 1929-30 averaged about Rs. 34 lakhs annually and amounted to Rs. 48 lakhs during 1930-31. India also imports large quantities of manufactured timber (furniture, cabinetware, etc.). The post-war average value of these imports was Rs. 53 lakhs.

From the foregoing it may be deduced that India *excluding* Burma imports about half as much timber as she produces for trade purposes. It should not be difficult to visualise a time when India with increasing industrialisation, increasing population and an increasing trend towards Western ideas will require at least four times as much timber as its trade at present handles. In spite of the swing of the pendulum towards substitutes for timber, the demand for timber must increase. When this time comes the difficulty will be to meet the demand. India without Burma is unlikely to meet it, and until the present depression started, the forests of Burma were worked up to their full sustained productive capacity. In fact the output was composed of surplus stock rather than increment.

With increased industrialisation the market will require a durable and easily worked timber at a reasonable price. India has few softwoods and the climate is against their use. It has however, notably in Burma, the finest and most durable timber in the world, namely teak. Proper management should bring teak forward as the required timber. No species is easier to grow than teak and Burma has shown in its plantations that mass production of this species is not a difficult proposition.

In addition to timber there are many other products of the forests of India that can and should be developed. It seems strange that India with vast resources in bamboos and grass should pay out some 3½ crores of rupees annually for paper and allied materials including some Rs. 40 lakhs annually for wood pulp to countries outside the British Empire.

The Forest Departments of the Indian Empire during the present period of depression should concentrate their energies on studying and protecting their resources so that when the depression lifts they may not be found wanting. The market is there. Saturation point for timber is further removed in India than anywhere else in the civilised world, and although hard times may call for a temporary policy of retrenchment in forest development, there are no grounds for despondency as regards the future.

THE CULTIVATION OF *TUNG (ALEURITES FORDII)* IN THE SHAN STATES.

BY A. LONG, B.SC., BURMA FOREST SERVICE.

The importance of *tung* oil as an essential raw material of varnish manufacture, especially where tough water-resistent films of high gloss are required, is well-known. It is also used in the manufacture of electrical insulating varnish and is of importance to the paint industry. In view of the importance to the paint and varnish industry, it was felt that the industry should be freed from its sole dependence upon China for supplies of the oil. Plantations were therefore started in the United States of America and in the British Empire. The present note deals with the work undertaken in the Southern Shan States Division.

Objects of the Plantations.—In the absence of an Agricultural Department in the Southern Shan States these plantations have been formed experimentally by the Forest Department to ascertain if *tung* can be grown successfully near Taunggyi and its neighbourhood, and if the tree will yield *tung* oil of commercial quality. As the Forest Department has not the staff nor the time to treat the tree on agricultural lines, it is being treated as a forest plant. Considering that the plantations are small and that all the produce obtained will be required for further local experiments in the division, it will be realised that it will not be possible to satisfy outside requirements.

Distribution.—Tung (*Aleurites fordii*) does not grow naturally in the Southern Shan States Division but *A. montana* is reported from the Mong Yawng Circle of the Kengtung State. *A. moluccana* has been planted as a roadside plant near Heho (22 miles from Taunggyi, the Federal Capital, on the main Thazi-Taunggyi road) and Yawnghwe (capital of Yawnghwe State, on the road to Fort Stedman). A few trees were seen in a *phongyi kyaung* (Buddhist monastery) in Lawksawk (capital of State of same name and situated about 60 miles from Taunggyi).

Past history and past attempts.—The first mention of Burma in connection with the cultivation of *tung* oil is found in Technical Paper

No. 1 on *Tung* Oil by Dr. L. A. Jordan, D. Sc. F.I.C., an extract of which (from Appendix A, pp. 11 and 12) is given below :—

> *Burma, April*, 1923.—" Following the discussions at the Institute with officers of the Forest Department on leave as to the possibilities in Burma an enquiry was conducted by the Divisional Forest Officer, Southern Shan States Division, as to the occurrence of the *tung* oil trees in those States. *A. montana* was found to occur in the Kengtung State, and it was stated that supply of the fruits would be obtained for experimental planting. It was reported that *A. fordii* with its higher range of elevation was expected to prove more successful for general cultivation and arrangements were made by the Institute for a supply of seed of this species. It has not yet been possible to obtain any information as to the progress of these experiments."

It will perhaps not be out of place to give, at this stage, a brief description of Taunggyi near where the experiments have been carried out.

Taunggyi, the Federal Capital, is situated in 96 degree 58′ E. and 20 degree 47′ N, at an elevation of about 5,0(0 feet, and is distant 104 miles from Thazi railway station on the Rangoon-Mandalay main railway line, with which place it is connected by a motor car road as well as by railway which has its terminus at Shwenyaung, 12 miles short of Taunggyi. The rainfall averages about 60 inches and it is mostly confined to the rainy season, May to October. One or two light showers of rain during the remaining months of the year are not uncommon. The shade temperature varies from a day maximum of about 90 degrees in the height of the hot weather to a night minimum of about 32 degrees in the winter. The underlying soil is limestone and the surface soil a fairly stiff brown loam containing little or no lime.

1923.—3 lbs. of *A. fordii* seed was received from Hankow in September, 1923, but no records exist of its cultivation. 5 lbs. of *A. montana* was received in December 1923 from Hong Kong. The date of sowing is not known but it is said that the plants germinated after

45 days and that the germination was fair. The plants flowered in May 1927, and were transplanted the same year. By 1928 the plants were 6′—7′ high, but had apparently not fruited. These plants have since been lost sight of and have been written off.

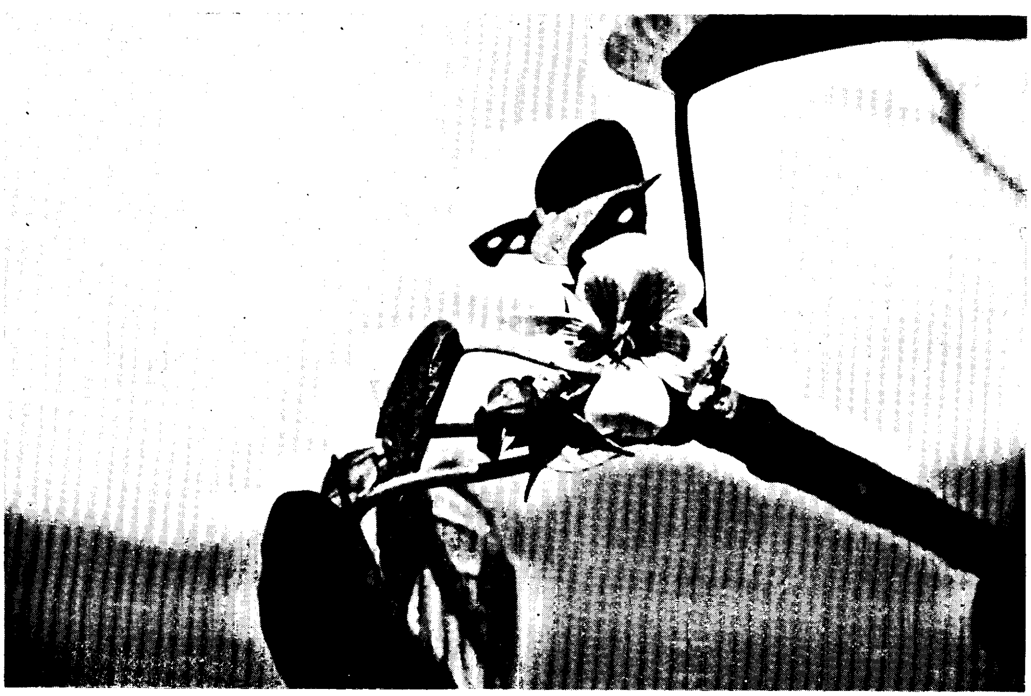
1928.—At the instance of the Inspector-General of Forests, *tung* was again tried in 1928 in accordance with instructions given by the Chief Conservator of Forests, Burma.

Three consignments of *A. fordii* fruits were received in 1928, two of 16½ tolas and 3½ lbs. being received from the Silviculturist, Dehra Dun, in April and in December, respectively, and one from Kew, through the Director of Agriculture, Burma.

The 16½ tolas yielded 30 seeds which were sown on the 6th June 1928. 29 seedlings germinated 8 days later giving a germination per cent. of practically 100 per cent. The nursery was watered daily during the dry weather, and at the end of February 1929 when the plants were about 8 months old they were 8″ high. Only 40 per cent. of the second consignment from the Silviculturist, Dehra Dun, was good. The consignment from Kew yielded 830 seeds of which 650 seeds were sown on the 5th June 1928 at a spacing of 20′ × 20′ at an elevation of about 3,500 feet in the Hopong Valley, about seven miles from Taunggyi ; and the balance on the 20th June 1928 in the Taunggyi Fuel Reserve, about three miles from Taunggyi.

The first area was situated in typical *ya* (shifting cultivation) country, on which sugarcane and wheat are grown, wheat following sugarcane, after which the land lies fallow for three years. This area being situated where control was impossible suffered from floods and damage by man and cattle in spite of the fact that it had been fenced. The exact date of germination is not known but 130 seedlings germinated by the 20th July 1928 and about 200 seedlings by the 10th September 1928 giving a germination period of about 45 days and a germination of about 30 per cent. It was thought that the low percentage obtained was due to the seeds having suffered in transit or being infertile but subsequent results show that this opinion is probably incorrect and that the consignment was a normal one. 72 seedlings survived

Tung (*Aleurites fordii*) in fruit: Plantation No. 7 of 1929; second year of fruiting with 14 fruits, June 1933.



Aleurites fordii in flower.

Long :—" Cultivation of *Tung* (*Aleurites fordii*) in Southern Shan States ".

till the end of February 1929 when they were 6″—7″ high. On the 21st March 1929 only 57 plants remained and by the 20th November 1929 all had disappeared.

The seeds sown in the Taunggyi Fuel Reserve were sown in a potato *ya*, elevation about 4,200 feet. Germination was very slow and erratic and the germination was about 50 per cent. Most of the plants withered away during an exceptionally long break in the rains and by the end of February 1929, only 19 plants survived and were then 6″ in height.

Plantations from 1929 onwards.—Useful data on the cultivation of *tung* were obtained from 1929 onwards. The plantations were all formed in the Taunggyi Fuel Reserve South Block after this date, and numerous experiments were carried out. As this took up much of the time of the range staff, it was later decided to treat the tree more or less as a forest plant and to confine operations to the following :—

(*i*) To plant the trees out,

(*ii*) To keep the ground under them free of weeds,

(*iii*) To obtain some figures for oil yield when the trees came into flower.

The information so far obtained from the experiments carried out with *Aleurites fordii* is given in the succeeding paragraphs.

Source and quality of seeds, etc.—Consignments during 1929 and after were received either from Kew or from Nanking. The Nanking consignment gave 172 seeds to a pound and the Kew consignments gave from 116 to 122 seeds to a pound. Mrs. Dorothy Norris in "The establishment of *Aleurites fordii* (*Tung* Oil) in the Ranchi District of Chota Nagpur", 1933, says that in America 2 lbs. of seed is expected to give about 120 seeds, sufficient for one acre of plantation if all germinate.

Quality and Germination.—She states that "in practice 75 per cent. germination is assumed and therefore 3 lbs. seed per acre is the usual allowance. It is not stated there what spacing is adopted in America, but 120 seeds, if sown one to a stake, would give 120 plant to the acre, *i.e.*, the spacing will be about 20′×20′ square planting or a

little less. The spacing adopted in the Taunggyi Fuel Reserve is $24' \times 24'$, square planting. The reason for this being that this spacing is a multiple of $6' \times 6'$ which is the general spacing adopted for the other tree species. The above spacing of $24' \times 24'$ gives about 75 trees to the acre.

The quality of the seed received has varied a great deal, results obtained ranging from nil to about 34 per cent. One consignment from Kew gave no results whatever while another gave 25 per cent. The consignment from Nanking gave 34 per cent. The germination period in both cases was about a month. Exept for the extraordinary results obained in 1928 from seeds received in April, when the germination obtained was practically 100 per cent. and the germination period eight days, subsequent experiments gave below 50 per cent. germination and a germination period of from one month to 45 days.

Nursery Practice.—This appears to differ from American practice as recorded on page 76 of "Questions and Answers on *Tung* Oil Production in America" but is the usual practice familiar to Burma and India. Instead of being planted in rows not less than three feet apart to permit ample cultivation, the beds are made three feet broad (length as required) and the seeds are sown about a foot apart in the rows, which are themselves a foot apart from each other. No cultivation is of course possible under such circumstances. No manure is applied and beyond the usual weedings the beds are given no special treatment.

Date of sowing in nurseries.—It is mentioned in the book above quoted that the months late in the dormant season (January and February) are the best months to plant the seed. At Sabaya (India) sowing was carried out in May 1928. At Namkum (India) seeds were sown, one lot on the 25th and 26th June 1928, and a second lot on 5th July 1928. Results appeared to be about the same,—germination took place, in about thirty days, the germination per cent. being 77 and 45 in the two places, respectively. A further consignment of seeds received in 1929 was sown on 15th March 1929. Germination commenced in 32 days, the germination per cent. in this case being 94. It

was thus stated by Mrs. Dorothy Norris that these figures would indicate that the end of the cold weather is a better time for sowing than at the onset of the monsoon. Sowings near Taunggyi have been made during May and June, on no fixed days. It has been mentioned elsewhere that the sowing made on the 6th June 1928 gave the best results—practically 100 per cent. Other sowings in May and June have given results varying from 30 per cent. to 50 per cent. while sowings made in mid-August 1929 gave no results whatever. There are no records of any sowings having been made in March and experimental sowings in March will be tried when a sufficient supply of seeds is obtained from the local plantations.

Preparation of the land.—In American practice, the land is prepared in the same way as for planting any farm crop, *i.e.*, intensive management is necessary. In Sabaya a piece of waste land, cleared of undergrowth only, with holes 3 feet square and 3 feet deep were made at a spacing of 30′ × 30′ square planting. This was later found to be too great a spacing and an extra plant was placed at the intersection of the diagonals of each square. In Namkum, the working was more intense, the plot being kept under cultivation by ploughing and harrowing after the plants had been transplanted to holes 1½ feet deep at a triangular spacing of 20 feet.

Both methods, with modifications, have been tried in the Southern Shan States. In certain States where the cultivation of *tung* is being tried experimentally, waste land has been cleared and holes have been dug 18″ deep and a foot square at a spacing of 20′ × 20′ square planting and direct sowing as well as transplanting has been tried. Near Taunggyi the preparation of the soil is more intense but has not been made so particularly for the cultivation of the *tung*. It is here grown in potato *yas*. For the information of those readers who are not acquainted with this form of cultivation, the following brief description is given. In September the undergrowth is cut and while the earth is yet soft the land is ploughed and harrowed. In December the trees are cut, parts suitable for firewood stacked and subsequently disposed of, and the remaining branchwood, twigs, roots, etc., heaped up at intervals on the cleared ground. These heaps are allowed to dry

and are then burnt in March. After the burning the soil is raised into mounds with a *mamootie*. Some farmyard manure (cow dung) is next placed inside each mound and burnt. In April these heaps are levelled, lines roughly marked on the ground, potatoes sown in these lines and the earth heaped up over them to form parallel raised lines. The area is staked soon after the ground has been levelled 6′×6′, if the *tung* is to be cultivated with other species, or 24′ × 24′ if it is intended to be cultivated pure. The direction of the raised lines depends upon the slope of the hillside and on the amount of rainfall. It is an important detail which if neglected results in the potato crops being washed away by the rains. No forest crops are sown this first year. They are put down in the second year only.

Direct Sowing.—Direct sowing, though successful, cannot be relied upon as the results depend to a great extent upon the quality of the seeds sown. It has been shown elsewhere that the results obtained have been below 50 per cent. and although this method is comparatively cheap, the costs are increased by having to fill up blanks with transplants. Direct sowing with selected Florida seed obtained from the Hsumsai Tung Estates, Northern Shan States, when tried in certain States gave little or no results, the best results being 10 per cent. obtained in the Yawnghwe State. Owing to the uncertain results obtained by direct sowing it is perhaps best to plant up areas with transplants. This method is, in the long run, less expensive and takes advantages of the growth already obtained by the nursery transplants. In the Northern Shan States where there is a private company cultivating the *tung* plant on a commercial scale at Hsumsai, direct sowing is preferred.

Transplanting.—Experiments have shown that the *tung* (*Aleurites fordii*) transplants well. One-month-old, three-months-old, one-year-old and even older seedling transplants have been tried with success. Transplanting was first tried with balls of earth but later even this was dispensed with. During the rains of 1932 *tung* seedlings from congested nursery beds, sown in May 1931, were dug up and were distributed to the Chiefs of various States. Wherever possible they were planted the same day as they were dug up but in one or two cases seedlings

were dug up the previous night, and because of the distance of some of the States from the nursery, planted only the following day; but even in such cases the plants transplanted well and survived, if reasonable care was taken in the digging up of the plants and they were reasonably well protected during the journey. Some idea of what the plants can withstand will be obtained when it is mentioned that the seedlings for transplants were transported on the carrier behind a touring car protected from the heat of the day by a light covering of plantain leaves. In most cases the plants have been transplanted whole, but in a few cases the plants have been cut back to a height of about 18″ and in one or two cases they were cut down to a height of about 2″—3″, the roots also being pruned below the carrot-shaped portion, *i.e.*, they were transplanted as "stumps." All these methods have proved successful. In some cases seedling transplants have died back a few inches, but this was not usual, as this dying back was confined to only a small percentage of seedling transplants in one and the same area. The explanation for this is not known.

Time of transplanting.—The time for transplanting one-year-old seedlings to the "grove" is given, in America, as the dormant season (December to March). In India transplating was tried in August (Sabaya) in good weather conditions, in September and in November (Namkum). Transplanting in the Southern Shan States has been tried at different times; one-month-old transplants having been put down at the end of July during the rainy weather; three-months-old transplants towards the end of October, and year-old transplants during the rains. The results obtained from transplanting have been better than that from direct sowing, the percentage of success being above 50 per cent. All casualties are filled up the same year, so that when the plantations are a year old the stocking is practically complete.

Manuring.—Manuring experiments were carried out in 1930 but were discontinued as much time was taken up and it was found that the results obtained showed little difference between the manured and untreated plots.

Weeding, etc.—The potato cultivation is carried out on each area for two to three years in succession. In the first year potatoes

are put down but no seedlings are planted. The *tung* seedlings are put down in the second year and for that year and the following year the cultivators weed the areas free of cost. It might be mentioned here that cultivators are permitted to cultivate inside the reserve in return for free labour. They are induced to cultivate the *tung* areas after the above usual period of three years, and paddy has been tried as well as wheat. From the result obtained it is preferable that wheat should be cultivated and that the cultivation of rice restricted to a minimum, for the reason that the wheat is cultivated during the resting period of the *tung* while the paddy cultivation is made during the growing season of the plant. By means of the above cultivations the area is kept free of weeds without cost. The cultivation of cover crops has not yet been tried nor is it necessary while the above system of cultivation continues.

Growth.—Figures of growth are available from 1929 onwards. The area now under *tung* (*Aleurites fordii*) amounts to 32 acres, (26 acres in 1929, 6 acres in 1931).

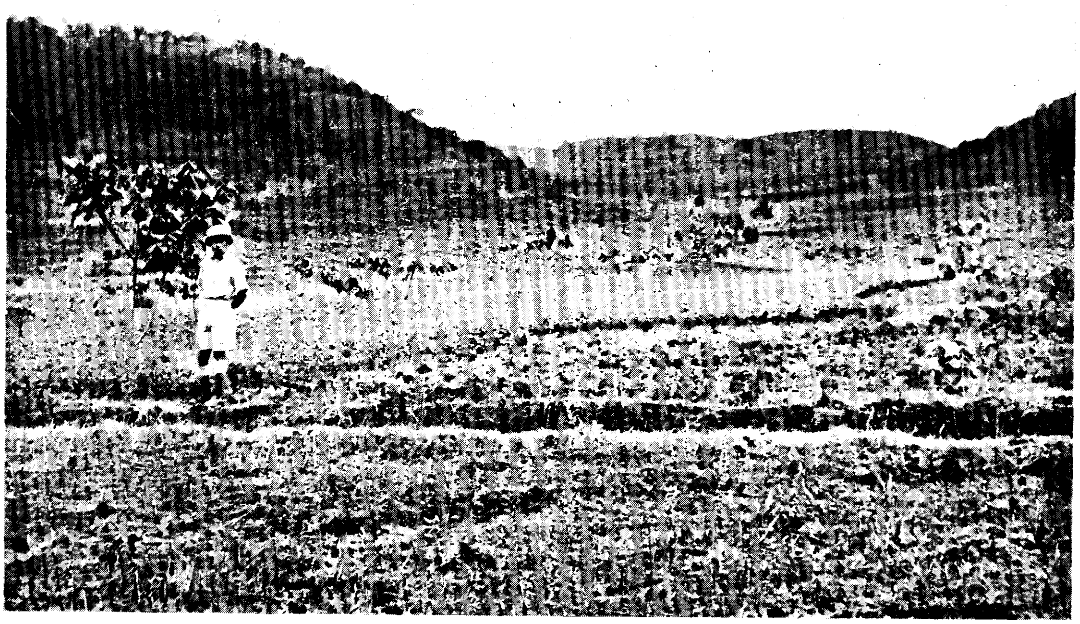
The following table shows the average heights of *Aleurites fordii* in different years :—

Species.	*Growth in feet and inches at the end of*				
	1st year.	2nd year.	3rd year.	4th year.	5th year.
A. fordii ..	1′ 0″	1′ 6″	4′ 5″	5′ 5″	..

Flowering and Fruiting.—Some of the 1929 plantations flowered for the first time in March 1932 and again early in March 1933. Flowers appear before or with the new leaves in March and remain on the trees till about mid-April when most of them fall and fruits form. The flowers are of the usual type, one flower in each cluster is female, the remainder all being male.

The fruits ripen in September. All the plants in the 1929 plantations did not flower. The following statement shows the number of

Ploughing between the *tung* lines in 1929 plantation for potato cultivation, which keeps down weeds: stump transplant in left foreground.



Tung plantation of 1929 with potato cultivation: area behind ditch in right foreground is not under cultivation.

Long:—"Cultivation of *Tung* (*Aleurites fordii*) in Southern Shan States".

fruits obtained from the 1929 *tung* plantations :—

No of plot.	Area in acres.	Total No. of trees.	No. of fruit collected.	Yield		REMARKS.
				per tree.	per acre.	
1	3	189	4	·002	1·3	*The average height of trees is best in this plot being 4′-7″ whereas in No. 1 it is 3′-10″ and in No. 6 it is 4′-3″.
6	15	840	46	·055	3	
7	6	451	58	·128	9·6*	
3	24	1,480	108	·073	4·5	

Compared with the results obtained at Sabaya where 67 two-and-a-half-year-old plants set 50 fruits, the above seems poor indeed. It should, however, be noted that the above fruits were all sound. The above fruits were sent to the Forest Economist, Forest Reserach Institute, Dehra Dun, for analysis. The results obtained are given below :—

	per cent.
Shell	38·4
Kernel	61·6
Moisture in kernel	4·2
Oil content in kernels	46·5
Oil content in kernels (on moisture-free basis) ..	48·5

The above compares less favourably with a sample of fruits obtained from the 1932 crop sent from India to the Chairman, Advisory Committee on Essential Oils and Resins, Imperial Institute, London, the results of which as far as the above items are concerned, are given below :—

	per cent.
Shell	38·1
Kernel	61·9
Oil in kernels	64·9

Chinese seed, according to Technical Paper No. 1, is said to give 58·3 per cent. oil in kernels by analysis, although the information is only very approximate.

Costs.—No figures of cost can be given as the work has been done by forest villagers in return for land for potato cultivation in the reserve.

Aleurites montana.—As mentioned earlier in this note, 5 lbs. of *A. montana* seeds were obtained from Hong Kong in December 1923. The germination period of this consignment was said to be 45 days and the germination is said to have been fair. The plants flowered in May 1927 but apparently did not fruit. They were 6′—7′ high by 1928. Later consignments of this species received in early July 1929 and in 1930 gave no results, the seed probably being bad. There are no plantations of this species but it is quite likely that there may be a few plants mixed with the *A. fordii* in the *tung* plantations. If these survive, fruits will be collected from them and further experiments made with this species.

Summary and Conclusions.

1. It has been established that *Aleurites fordii* can be grown successfully near Taunggyi and in certain States of the Southern Shan States Division.

2. That *tung* (*A. fordii*) is a hardy plant, stands transplanting well and is fairly frost hardy.

3. That transplanting can be carried out almost any time during the rains.

4. Flowers in early March before or with the new leaves. Fruits ripen in September, about the same time as they ripen in India, but a month earlier than in America where the main crop appears to be gathered in October.

5. That in spite of the poor methods of collection of fruits—(some were collected before they were ripe)—the results obtained are encouraging.

6. That efforts to establish *A. montana* so far have proved unsuccessful.

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KULU AND SERAJ.

BY A. M. DAVID, I.F.S.

(*With apologies to the Himalayan Journal.*)

Those who are allowed to stand on the 'Ridge' in Simla for a short while, without being knocked down by a *musth* rickshaw, will see a mouldy collection of mountains to the north. No one knows or cares that these mountains conceal the district of Kulu with Seraj for an appendix; a well flung outpost of our far flung Empire. A bare seventy-five miles as the crow flies separates Simla from Kulu but, unless the Accountant-General has classified you as a crow for the purposes of travelling allowance, the journey will occupy ten days and cover 122 miles. The first forty miles to Narkanda, however, can be done comfortably in a rickshaw but the rest of the pilgrimage

will have to be made either on foot or on a hill pony ; both poisonously uncomfortable. The Sutlej river is crossed at Luri and from here to the Jalori Pass one sweats through some of the most delightful country this side of the Athol Brose in the outer Hebrewdes.

[*Ed.*—Can't we stop here for a few days ?

Author.—No, you've got to come to Kulu with me.

Ed.—Lead on, Thos. Cook.]

The top of the Jalori Pass is the last opportunity the traveller will have to enjoy a decent breath of fresh air and he should inhale this opportunity with both lungs. Banjar is reached in one day ; the road passing through the quaint bazar where Asiatic 'hot dogs' will be frying in their own peculiar smell and dirty dogs giving off a similar smell. There is nothing to see from the rest-house which, if Providence has been kind should, by now, have been demolished by the explosion of the adjoining powder magazine. The last stage through this wonderful country is a long twelve miles to Larji. The view from this bungalow will hold the traveller spell-bound. In front is a lovely barren hill with some splendid landslips ; to the east is another bazar but there is no need to go into it because it will come to you, the last house almost touching the bath-room ; and to the west will be seen part of the main road to Kulu. Good sport can be had sniping the motor lorries. There may be some difficulty getting into the bungalow, but the sweeper is a very obliging old man and will, without much protest, remove his cows from the bed-room. Two miles from Larji is Oot which is on the main road. Some people prefer to call it 'Out' and if the straight tip is taken the traveller should turn left. But having got so far it may be advisable to see Kulu so that a readable and romantic description can be written about the apricots which no one wants to eat ; the stately mountains which no one wants to climb ; the beautiful beauty which does not exist ; the magnificent fir trees which everyone knows are hollow ; the picturesque people who combine the effluvium of the Banjar 'hot dogs' and dirty dogs, and several other fictitious little observations calculated to mislead a gullible public.

Kulu lies between certain latitudes and longitudes and the traveller need not worry about these; they have been very carefully worked out so Kulu will have to be left where it is. A pity;—particularly if one is liable to attacks of claustrophobia. Manali must be visited whether the traveller wants to go there or whether he doesn't. A few of the snowy peaks will be visible and most of these have been compared, by me, to every 'horn' in Switzerland. There is one peak which looks like Popocatapetl but, of course, it isn't. About the only things to which the epithet virgin can truthfully be applied are some of the peaks, but, fortunately, one cannot see them from Manali or anywhere else. In 1926 a girl guide successfully climbed to Nagar up the west face of the mountain. It is interesting to note that the real name of the Beas is Hyphases and that Ptolemy I was the first man to break a soup plate in the Nagar dak bungalow for which, according to the bungalow book, he paid two drachmæ.

The Parbatti, so called because no Englishman had seen it before it was christened, rises somewhere near Mant Rai but no one knows why. There is little of interest in this valley. The straggling village of Manikaran will at once be associated with an unsealed retort of sulphuretted hydrogen; otherwise this valley is comparatively quiet. From Jari a very fine view is obtained of a sheet of rock and some *chamars*' hovels. Looking downstream from the verandah one gets a pretty glimpse of the kitchen and servants' quarters.

Kulu and Seraj provide some excellent shooting but big heads are not to be expected. Anything which can take a $7\frac{3}{8}''$ solar topee is rare. Forest guards and patwaris are protected and may not be shot; even on a license. There are few mountains in Kulu and Seraj worth climbing and, therefore, no one will bother to climb them. The pumpkins and wayside trees (*Roadsidea dustiflora* spp.) will provide plenty of interesting material for the botanist while the photographer will be able to fill any number of albums with photographs of himself sitting on a rock or pushing debilitated cows out of his way. At Manali the ornithologist will find a large variety of interesting and pretty birds. The advent of mechanically propelled internal com-

bustion transport, better and briefly known as the motor, is a definite blessing because it enables the traveller to get out of Kulu in four hours instead of four days.

The high escarpment at Bhuin, as a result of the rapid cooling of a geological blanc-mange, appears to have stopped too soon. If it had only continued across the Beas, curled round and gone up the Mohl khad, Kulu would have been a lake. As Mr. Sellars has said on more than one occasion this, perhaps, would have been 'A GOOD THING.'

THE SELECTION OF RADII FOR STUMP ANALYSIS.

BY H. G. CHAMPION AND I. D. MAHENDRU, SILVICULTURAL BRANCH, F. R. I.

The question of the selection of radii for stump analysis came up originally when a standard procedure for stump analysis was being worked out for general adoption in India with the approval of the Silvicultural Conference held in 1929. In the description of the accepted procedure as given in the Silvicultural Research Manual, Volume II, pages 49—70, no mention is made of the field tests which formed the basis of the prescriptions. Subsequently it was thought desirable to publish the data collected, so they have been summarised in the following paragraphs.

It was clear at the outset of the work that there was considerable lack of uniformity in the selection of radii, as recommended by different authors, and as actually done by various workers carrying out such work in the field. This variation is due to the wide range of selection made possible by the irregular shape of stumps and the conventional sense in which the term diameter is understood in forest mensuration. In the strictly mathematical sense, a precise and implicit relationship exists between the diameter and the closed area of the figure to which it belongs, *i.e.*, between the diameter of a circle and its area, so that

for a given area, there is one and only one diameter which corresponds to it. *On the other hand, in the conventional sense, the diameter* is measured as the normal distance between two parallel tangents, and requires to be referred to an imaginary circle having an area equal to that of the section at the point of measurement. On account of the more or less irregular shape of the section, and the difficulty of determining its area, strict correspondence between the area and diameter is, however, lacking.

In general, for the fairly regular sections well above the base of the stem, say at breast height or 4′ 6″, the circular area derived from the mean diameter as callipered is assumed to be the area of the section, and the relatively small difference between the two areas is considered negligible compared with other errors of measurement. In the case of lower sections with pronounced irregularity of outline, the callipered diameter is remotely and only very approximately related to its area. But the value of selection of radius or diameter in stump analysis *does not rest on the relation of the selected diameter to the stump area, but on its relation to the diameter at breast height.* It must be strongly emphasised that the whole object of stump analysis is to derive data as to growth in diameter at breast height, where measurements are made for all practical purposes.

To test the significance of selection of diameters as providing approximations to the true area, the following measurements were taken on 28 stumps of *Cedrus deodara* :

(*a*) *Two callipered diameters at right angles to each other.*— These were measured in the ordinary way, callipering proceeding from the uphill side.

(*b*) *The longest diameter through the pith and the one perpendicular to it, taped on the stump.*

(*c*) *Four radii from the pith as widely paced as possible.*

In locating these radii, care was taken to avoid portions where growth was not typical for the stump. Further, as far as possible, only radii approximating closely to the average radius were selected,

thus avoiding appreciably shorter or longer radii, though a pair together equalling the mean diameter, one rather longer and one rather shorter, were not objected to. Where the selected radii were actually at right angles, the resulting measurements were equivalent to two diameters perpendicular to each other. The measurements of these diameters were not necessarily identical, however, with those obtained under (*a*) above, as in this case the callipers were not used; they might be shorter, but could not be longer.

Additional measurements were taken on each stump to obtain a better approximation to its true area. It was found best to work with Simpson's rule for approximate integration. For this purpose, a line was arbitrarily drawn across the surface of the stump and divided into an even number of equal intervals each about 1 inch long. Ordinates perpendicular to the base line were then drawn through these points to the cambium and measured. The required area was calculated as approximately equal to the sum of the extreme ordinates plus four times the sum of odd ordinates, plus twice the sum of even ordinates, *all* multiplied by one-third the common interval between the ordinates. Planimeter readings might have been taken on paper outlines cut to cover the stumps exactly but unfortunately this was not done.

For the comparison of methods, a diameter value was calculated from the stump area as determined by means of the Simpson's rule, and the following statement gives the deviations of different average

diameters from those obtained in this way :—

Serial No. of stump.	Average of two callipered diameters.	Average of longest taped diameter and one at right angles to it.	Twice the average of the four radii.
	Deviations from the diameter determined from the area of the stump.		
	Ins.	Ins.	Ins.
1	−0·2	−0·4	−0·4
2	−0·2	−0·3	−0·9
3	−1·5	−1·0	−1·4
4	−2·4	−0·5	−3·7
5	−0·7	−0·5	−0·4
6	−0·7	−0·7	−0·4
7	−0·7	−0·2	−2·3
8	−0·7	−1·0	−4·9
9	−1·7	−0·6	−0·3
10	−1·2	−0·4	−0·2
11	−0·3	−0·1	−0·2
12	0	−0·9	−0·9
13	−1·3	−0·1	−0·8
14	−1·4	−1·0	−3·2
15	−0·5	−1·4	−3·2
16	−4·4	−2·4	−2·6
17	−2·4	−1·0	−0·9
18	−0·1	+1·9	±2·0
19	−2·7	+1·0	±0·5
20	±0·3	±0·9	±0·8
21	±0·4	±0·3	±0·2
22	±0·9	±0·5	±0·7
23	±0·7	±0·9	±3·7
24	±2·2	±0·2	±3·7
25	+3·5	±0·7	0
26	±0·5	±0·1	±1·3
27	+0·5	±0·4	±0·5
28	±0·1	±0·2	±1·1
Mean deviation ..	±1·11	±0·24	±0·84
Deviation percent	+3·2%	±0·7%	±2·4%
Standard error ..	+0·21	±0·12	±0·25

It is seen that the mean deviations are all positive, so that the diameter measurements actually taken on the stump are on the average greater than the diameter value obtained from approximate integration. Comparing the methods with one another, the difference is seen to be greatest with the pair of callipered diameters, and least with the longest diameter through the pith and the one perpendicular to it, while the four radii method takes an intermediate position. The average of the longest diameter through the pith and the one perpendicular to it does not in fact differ significantly in this example from the theoretical diameter. As, however, it can be shewn that the stump diameters obtained by all three methods can be corrected to d. b. h. with equal precision, no case has been made out in favour of the choice of longest diameter and the one perpendicular to it in preference to the selection of four radii as widely spaced as possible, or the two callipered diameters. The co-efficients of correlation between measurements obtained by the three different methods are $0{\cdot}94 \pm {\cdot}02$, $0{\cdot}90 \pm {\cdot}04$, $0{\cdot}92 \pm {\cdot}03$, between methods I and II, between II and III, and between I and III, respectively, thus justifying the inference that significantly different correlations are not to be expected with d. b. h. values. The problem accordingly is altered into that of ease and accuracy of ring differentiation and for this the advantages of the four radii method is unquestionable.

However, in stump analysis, a taper curve is the actual correlating mechanism used for converting the stump diameter into the corresponding breast height measurements, and the data for this must often be collected separately on standing trees. This implies the necessity for correspondence in the measurement of stump diameters in the collecting of taper data and in the actual work of analysis. When the taper data are based on callipered diameter, as is generally the case, it follows that the selection of diameters for analysis should also be based on the callipered measurement. In the example given it is, however, shown that the average diameter obtained from four radii does not differ significantly from that derived from the pair of callipered diameters as the mean difference is $-0{\cdot}27 \pm 0{\cdot}19$, which is not mathematically significant. It appears therefore that it may be a

matter of indifference whether four radii or a pair of callipered diameters are taken, though it is impossible to generalise from this small example, and it might be expected that a varying personal factor would be introduced in the extent to which deviations are made from the rectilinear relation of the radii analysed.

Methods have sometimes been put forward in this country in which the value of selection is emphasised from the point of view of correlation with stump area rather than with diameter at breast height. It is easy to see the value of a larger number of radii often recommended for analysis in these methods, but their weakness lies in the scant attention given to establishing the correlation between the stump diameter and the diameter at breast height. Thus there is commonly no gain in accuracy of the end results obtained, and the extra amount of time and labour involved does not appear to be justified. The 16 radii method which has been used in Burma is a typical case in point. While no less than 16 radii, $22\frac{1}{2}$ degree apart are recommended for analysis, it is considered sufficient to assume empirical relationship of rough equality for the correlation of stump diameter with diameter at breast height, which though perhaps suggested by the data, cannot be considered as statistically established.

The objections to generalisations based on a sample of a limited size and a single species are fully recognised. If however the conclusions set forth above are applied with due care and understanding of their statistical significance, they are less likely to lead to serious errors than the unconvincing attempts often made to establish methods on a non-statistical basis with the semblance of a natural law. Thus, for example, if in a given locality and for a given species the irregularity in stump shape tends to approximate to a stable or typical form, variation from the recommended selection of radii may become desirable, but this must be justified on a statistical basis with full attention to the considerations explained above.

'HAT TRICK.'

By an Amateur.

In 1921 I chanced to be placed in one of the thickest forests of Bombay Presidency which abounded with nearly all kinds of game,

but where tiger had not been shot for some years at least ; although as many as nine panthers had fallen to one gun alone within the space of three years. Soon after my taking over we heard various tales of damage being caused by felines in the villages round about the camp. A colleague of mine who was also stationed there had tried his luck but with no great success. He was able to bag one panther. One morning *khabar* was brought of kill about 8 miles from the camp. My colleague who had a certain amount of experience in shooting, was for certain reasons unable to go. As we did not like to disappoint the people who were especially enjoined to bring news of this nature immediately to the camp, I decided to respond to their call. Now I must mention here that I had hardly put in 2½ years of service in the Department and had absolutely no practical experience of big game shooting which, as I had heard, involved a certain amount of risk. My response was, therefore, more out of feelings for the people than for the fun of shikar which was really a secondary object. However, my colleague volunteered a few tips and I, having sent my bedding and an electric torch in advance, rode out to the site in the afternoon reaching there at about 4 p.m. I saw a huge bull of tremendous proportions had been killed in an open grassy patch with no tree close by. After surveying the ground I selected a fair sized tree on the slope (the country is hilly) and with the help of the local people, had a cot fixed—upside down among sturdy branches about 20 feet from the ground and secured well with ropes. I also had the kill dragged and secured by means of ropes with a huge wooden peg fixed close to and within 20 yards of the tree. This precaution was one of the tips given by my colleague though on account of the size of the bull it may probably not have been necessary. It is however a very useful and even an essential precaution as my experience on another occasion showed. The grass all round the hill was pressed back flat to afford a clear view. By 5 p.m. with some tiffin with me I was in the machan with my bedding nicely made and ready to make a night of it. For fear of creating any noise, I had left my shoes and the rainproof hold-all on the ground near the tree. I had also sent the people away and had asked one of them to come after he had finished his evening meal, to sit by me.

It was about the beginning of February and within an hour the light began to wane. All was absolutely still and I had just prepared to help myself to a little tiffin when I became conscious of a sound of something going through the grass, underneath and to the right of my tree. I forgot all about my tiffin ; my heart which was previously functioning normally began to hammer violently against my chest. I was all attention and awaited developments. The sound stopped, started again, stopped and started again. This went on for a couple of minutes. Obviously some animal was on the scent of the kill and proceeding with cautious strides. I quietly loaded my 12 bore gun with buckshot and awaited the entry of the animal on the arena. It had never struck me to look for pug marks on the ground nor would it have been of any avail as, without a shikari, nobody would have been able to judge the animal correctly. From the previous history of the locality all I could expect was a panther. To my horror, however, there emerged a full-grown tiger into view. As it was my first occasion to sit up for big game and, as I was all by myself, my nervousness was so great that I thought of firing in the air and bolting immediately. My heart also began to do double quick hammer. However I sat quiet and watched the tiger. It went all round the kill, stopping at all the cardinal points and intently gazing all round. When it had completed the ring I tried to change the buckshot for a ball cartridge and in doing so clicked the safety catch. The sound conveyed a loud enough warning to make the tiger bolt. Only a couple of seconds later another tiger emerged from the same direction and seeing its predecessor gone it also took to its heels. Bad luck, I nearly shouted. I cursed my foolishness and temerity.

I sat still. Not long afterwards it began to grow dark and sounds of something trampling over dead vegetable litter and twigs could be heard round about the tree. At about 6-30 p.m. the bull was visible in the star-light only as a black piece of rock against the white background of dry grass. I noticed something quietly approach the kill. On account of bad sight I had changed the ball for buckshot and fired at the tiger as it stood on the kill. The result was a complete miss. I

lay quiet again, as I dared not leave the *machan* to march all the way about half a mile to the village.

At about 9 a noise, similar to the one related above, repeated itself and on account of the stillness of the night was more pronounced than before. After some time a dark object again approached the 'rock' and completely mingled with it, I watched it for a fairly long time—it must have been fifteen minutes—and eventually took whatever aim I could and fired a ball cartridge this time, on the presumption that buckshot was not effective enough for a huge animal of this type.

Disappointment was writ large in all this amateurish endeavour. I imagined this last chance had also slipped by. The only other prospect of lying awake in the *machan* till day break stared me in the face. I had obviously missed both times on account of want of proper aim due to darkness. In spite of heavy odds against me I prepared myself again. Tearing a piece of white paper out of some wrappers, I made a notch and fixed it on the sight with the help of improvised paste from a *chapatti* and waited patiently. At about 11 an opportunity afforded itself again. I took a careful aim and fired a buckshot immediately behind the head of the tiger as it bent itself on the kill. To my utter surprise the tiger dropped dead, as if of heart failure. Whatever it was, I can hardly describe the feelings of excitement and satisfaction that followed those of tenseness and nervousness. For the first time I flashed my torch to view the stripes as they lay flat on the ground.

My spirits revived. Perched in my safety there was nothing to do but to lie still and draw up visions of being known as a tiger shooter. I could hardly sleep. Moments passed. At about 1 a.m. yet another tiger made bold to approach the kill. I was not in a hurry now to kill, and decided to watch and see. The animal took a couple of bites and getting nearer the dead tiger began to make the most hideous noises and bewailing cries after the fashion of somebody crying over a dead relative. As I had got used to the light reflected by the stars, I could clearly see this tiger trying to awake the dead one. This went on for about 15 minutes after which taking a steady aim as before I fired a ball cartridge just behind the head as the animal steadied itself.

There was a light growl, four deep breaths and dead quietness. I flashed the light but was unable to spot the tiger. I was dead certain I had killed it.

By this time the strain on my nerves had been great and after realizing that with all this firing I could not possibly hope for any further luck, I stretched myself on the bed and was at once in the realm of dreamland. At about 3 a.m. I was awakened with a sudden start by the noise of crackling bones. I imagined it must be a hyena or a jack feeding on the carcass. I took up an empty cartridge case and threw it on the kill. Back came the loud growl of a tiger and stillness prevailed again. The loaded gun was again pointing in the direction. The tiger took a bite then disappeared into a nalla close by to come back again and repeat its action. After some time I took aim and fired behind the shoulder just as it stood on the kill, a ball cartridge again this time. The tiger bounded into the cover and could be heard sniffing not far from the tree. As the sound continued I conjectured that the tiger was badly wounded.

At the break of day I climbed on to the topmost branch of the tree and spotted the tiger in the nalla. I could distinctly see that I had broken its back as in its efforts to move away it was dragging itself on its front legs. I also saw my second tiger lying flat on top of the first one. By this time the village had also turned out and were waiting for orders about 100 yards from my *machan*. I beckoned them to come and as they approached I shouted caution. I descended too and to my amazement found my shoes and the bedding hold-all missing. I had therefore to go in my hose. With a few men I advanced cautiously towards the nalla. The tiger as it looked round towards us presented a most helpless sight of utter humility. I finished him off and we all retraced our steps.

Extreme caution was still necessary, lest I may have wounded another tiger during my first two rounds which I thought had scored a blank. An examination of the tigers showed that I had bagged the tigress first which explained the bemoaning whines and cries of the cub, the second tiger, and also the reluctance of the two cubs to depart.

The villagers helped me to trace only one shoe. The bedding hold-all was torn into shreds. There was no trace of blood anywhere else. Making certain that I was not leaving any wounded tiger in the vicinity of the village, I rode back to my camp with instructions for the tigers to be sent over in a bullock cart. On arrival at the camp I felt unusually calm and composed. As I was without shoes and had marks of blood on me which I had got in helping to collect the bag, everybody looked at me with consternation. I suddenly blurted out that I had been attacked but had emerged safe out of the ordeal. It was bad to play on their feelings in this fashion. Not only was I scaring them out of their wits but I knew they would not believe that I had shot three tigers. I very dispassionately related my above tale to the eager listeners but it sounded so incredulous and artificial that my colleague, his wife, my wife and a few subordinates that had collected there merely shouted "A good yarn." The bullock cart arrived at mid-day and told its own tale. The measurements were 8′—1″, 7′—5″ and 7′—4″.

M. L. K.

EARLY STUMP PLANTING OF TEAK IN KANARA NORTH DIVISION.

By M. V. Divekar, Forest Ranger, Virnoli Range.

The following are the results of an experiment in early stump planting of teak, carried out by me last May, on the lines of my own observations and as a result of a suggestion from my Divisional Forest Officer that I should report these for the information of the readers of this journal.

With the commencement of the growing season, which usually begins in the latter half of April in these parts, activity in the vegetable kingdom is markedly noticeable. Trees, roots and stumps begin to put on new leaves, buds or sprouts. In their attempt to thrive during the hot weather they seem to tap the resources of moisture content in the sub-soil and from the atmosphere around. As a result, the rate of capillarity is probably accelerated and more moisture absorbed, to

supply the growing need of plant-life till the late April and May showers come to its rescue. Rapidity in growth and germination is noticeable after one or two showers. In burnt areas growth and regrowth starts much earlier. This is probably due to the stimulus given by the heat and the natural tendency of plant life to thrive in spite of adverse conditions. In spite of the fact that the severe burn deprives the upper layers of soil of its moisture contents, I find that the layer of soil just beneath the uppermost crust possesses a fair amount of moisture soon after burning. On comparison, before there was any shower, I observed that the particles of soil in burnt areas were more porous, loose, and contained a slightly greater percentage of moisture than the particles of soil in the adjoining jungle covered by humus, tree-growth and foliage. Stimulus caused by the heat is so great that the upper layers of soil and the root system absorb excessive moisture from the sub-soil to supply the enhanced need of plant life, which attempts to reproduce itself and to cope with the rapid evaporation caused by the direct rays of the sun. In the cool hours the soil probably draws in more moisture from the surrounding atmosphere.

1932 *Experiment and Observations.*—Knowing full well that teak possesses extraordinary powers of resistance to adverse climatic and other conditions and that the stumps can conserve food material for a considerable period and with a view to put to practical test the above observations of mine 100 stumps were put out on 3rd May 1932, it having rained lightly on 2nd May 1932. A thousand were planted on 6th and 7th May 1932 as there was a light shower on 5th evening. Till 16th May 1932 there was no rain. Regular planting was commenced on 17th May 1932 and completed by the end of the third week of June 1932. Regular monsoon started on 4th July 1932. There were two showers in May after 17th May 1932 and about five in June. On 20th May 1932 very few out of those planted on 3rd, 6th and 7th May sprouted and by 28th May 1932 a good many had put on shoots. By the first week of June the majority of the shoots of stumps planted early in May attained a height of 4 to 5 inches. Few out of those put out on 17th May 1932 and subsequent dates put on shoots

by the 24th of May and by the 15th of June 1932 almost all the May stumps sprouted. Casualties among earlier plantings were hardly 5 per cent, and those among later plantings of May and June numbered slightly less.

Planting done in July after the heavy rains, by way of filling in of casualties, did not give good results. Even the few that sprouted are hardly a foot high even now, while those planted in the normal season have attained an average height of 3 feet. During the months of heavy rain, when decided increase in height growth in the plants of earlier planting could be observed from week to week, a distinct check in growth was noticeable in the plants of stumps put out in July.

Results.—The following table gives the comparative height growths of plants in an average patch of 100 in each class recorded after nearly a year of planting of *very early, early, normal and late* plantings in the hundred acre plantation of last year. Stumps put out on 3rd, 6th and 7th May 1932 are classed among the very early plantings; those planted from 17th to end of May in early planting, those in June in normal plantings (as generally understood) and those in July as late plantings. The espacement adopted in all cases was 9′ × 9′.

Serial No.	Nature of plantings.	Height of the best plants in feet.	Average height of the dominant plants in feet.	Average height of the whole in feet.
1	Very early plantings ..	$12\frac{1}{2}$	6	$4\frac{1}{2}$
2	Early plantings ..	10	$5\frac{3}{4}$	$4\frac{1}{4}$
3	Normal plantings ..	$8\frac{1}{4}$	$4\frac{1}{2}$	3
4	Late plantings ..	$2\frac{1}{2}$	$1\frac{3}{4}$	1

Brief Notes on method of raising and planting stumps.—A short description of the type of stumps used and the method adopted in raising

and planting them in these parts, are given below. Late in March, soon after burning, nursery beds of convenient size are prepared in the burnt area and unweathered seed, if any, is sown, the weathered seed being reserved for sowing in the first or second week of May. The seedlings got from these nurseries are carefully pricked out when the weather conditions are favourable for planting and transplanted 6″ × 6″ in specially prepared beds in the same area. When the next planting season approaches, the thickest usually of 1/2″ to 3/4″ diameter, among the transplants, are dug out and used for early stump plantings, as they withstand the rigours of hot weather better being able to conserve food for a longer period. The root and the shoot are so clipped as to give roughly 6″ length, about 5″ of the tap root below the root column, and about 1″ of shoot. The stumps so prepared are planted in specially dug holes of about 6″ depth in an oblique position, cut surface facing upwards, and buried 1/2″ underground. The remaining plants from the nurseries are used for subsequent work during the planting season. Experience shows that stumps got from one year old seedlings, raised by the above described method, give better results than seedings raised otherwise.

1933 *Experiment.*—Encouraged by the results of the last year's plantings I have put out 1,150 stumps on 20th, 22nd and 23rd April 1933, after a heavy shower on the 19th evening, in the area of 107 acres, set apart for planting this year. Till 11th May there was no rain in this particular area. Regular planting was commenced on 11th May soon after a shower and completed by the 28th May. On 17th May a few stumps planted in April sprouted and on 19th May some of those planted on 11th, 12th and 13th May put on shoots. By the end of May about half the number of stumps, put out in April, and about 40 per cent of those planted in the second week of May sprouted; some of the sprouts of April plantings had attained a height of 4 to 5 inches. On 13th June by regular counting it was found that 94 per cent of the stumps planted in April, 90 per cent of those put out during the second week of May, 75 per cent of those put out in the 3rd week, and 60 per cent of those planted in the last week of May had

sprouted, and out of the rest, a good number are showing signs of sprouting and may put on shoots within the course of the next 3 or 4 days. Height measurements recorded on the same date show that some of the shoots of April plantings are a foot high, the majority being 6 to 8 inches high; those of early May plantings are 5 to 7 inches high, and those of late May plantings 3 to 5 inches high.

Conclusion.—Whether similar experiments carried on with teak in teak-bearing areas but with different climatic and other conditions will prove equally successful is rather hard to guess but interesting to speculate upon. The climate of this place is damp throughout the greater part of the year and the area selected for planting of teak is obviously suitable for the artificial regeneration of that species. Similar experiments carried on in the neighbouring ranges of this division, with slightly different climatic, soil and other conditions have given equally good results. Early planting of teak stumps carried on in the Teak Pole Area of Haliyal Range—a comparatively drier region, has proved successful. It is worth while trying experiments of this type, beginning on a small scale, in different types of localities, as the results thereof and experience gained are likely to prove interesting and to be of immense value.

BENMORE.

Any object lesson in co-operation between different departments of Government serves a useful purpose in India where so often one sees wasted effort and unnecessary waste of public funds by departments which are carrying out similar work in ignorance of what others are doing of a like nature. We would therefore commend the attention of all officers going on leave to Scotland to a visit to Benmore, where by means of skilful co-operation the Forestry Commission, the Board of Works and the Edinburgh Botanic Gardens are gradually producing one of the "show pieces" in a country already rich in attractions to lovers of nature. To those on a motoring holiday the approach is easy either by steamer to Dunoon or by road *via* Strachur and along Loch Eck-side, either of them being most enjoyable. Mr. H. G. Younger, the owner of Benmore estate on the Argyllshire coast,

made a gift of his estate to the nation on condition that it would be devoted to the advancement of silviculture and botany. The estate was originally a stretch of bare moorland, but the planting efforts of former owners have established some 2,000 acres of woodland including stands of many exotic species and an arboretum with many fine examples of individual exotic trees, while the policies around the mansion house are already well stocked with many interesting shrubs. The Commission have since acquired several other estates in the neighbourhood so that a practically solid block of forests and plantable ground of about 50 square miles is being dealt with under a planting programme of nearly 400 acres a year. At Benmore and Glenfinart are extensive forest nurseries, and a new interest is to be found in the numerous forest workers' small holdings which consist of up to 10 acres of fruit and farm land with a house rented for £6 to £15 per annum in return for a fixed number of days forest labour from the lessee.

The greatest attraction however is in the policies around the mansion house which are being developed by the Edinburgh Botanic Garden to form a woodland garden rich in *Rhododendron* species and hybrids. The Garden staff have specialised in the cultivation of *Rhododendrons* for many years since first the elder Balfour took up the study of the Himalayan alpine plants which his acquisitive Scots friends sent home to him. This work is now under the charge of the Assistant Regius Keeper, Dr. J. M. Cowan, who was formerly in the Indian Forest Service. The woodland garden in the modern sense is not the neglected tangle of native herbs which used to pass muster as such. Benmore already shows what sort of woodland garden can be accomplished by skilful planting of flowering shrubs under the copses and avenues of older trees, such as the Cathedral Aisle of stately *Abies nobilis* and fine groups of old native Scots pine, deodars, *Araucarias*, redwoods, South American beech, Douglas fir, cypresses and *Picea sitchensis*. The moist seaside climate with about 90" of rainfall has proved peculiarly suitable for alpine plants from Sikkim and Chinese Tibet and there are already some 200 species of *Rhododendron* alone established here, some of which are always in flower. The hillside which rises steeply behind the mansion house from the edge of the

flat "strath" lands beside the Echaig river is being laid out with small compartments each allotted to one of the main groups of cultivated *Rhododendrons*, and an easy path climbs up to a viewpoint which commands a superb view of the Holy Loch and the Clyde estuary.

Another delightful spot nearby is Puck's Glen. To quote Neil Munro, the Scottish author : "It were futile to attempt, in brief verbal fashion, any useful description of Puck's Glen, a name long years ago conferred on a mountain gorge whose singing waters fall to the Echaig river in secret pools and cataracts from lofty naked summits through woods of pine that already look primeval though planted in recent times. No photograph can adequately recapture all that makes this shy, wild cleft of the hills a part of fairyland." A footpath built by the water's side emerges on a level that affords a glorious view of alpine peaks and is crowned by a visitor's hut erected "to the memory of Sir Isaac Bailey Balfour, his great personal charm and scientific genius, and his lifelong service to a science which is the ministrant to natural beauty as much as to the utilitarian ideals of farmer and forester," and for this the Forestry Commission has dedicated this most charmingly poetical feature of the Eck Valley—Puck's Glen. To his name might well be added those of the plant hunters such as Wilson, Farrer and Forrest whose expeditions have done so much to enrich the store of alpine plants which is being developed to such perfection at Benmore.

A forest garden which it is anticipated will ultimately extend to 125 acres, is being formed at Rashfield, a couple of miles away near Kilmun, where the object is to produce in a small space a variety of forest crops growing under forest conditions, not only of the commoner trees but also of as many of the rarer varieties as can be obtained.

All these interesting features and also the opportunity of visiting the surrounding estates of Glenbranter, Balliemeanach and Inverchapel are the privileges of residents at the mansion house of Benmore. This has been put into use as a hostel for visitors and is open to all members of societies interested in silviculture or botany. Forest Officers from overseas who wish to go there should apply to the Assistant Commissioner, Forestry Commission, 25, Drumsheugh Gardens,

Edinburgh. The per capita tariff including board attendance and accommodation is 3 guineas a week ; preference is given to those who stay for at least a week and advance booking is necessary. A very attractively illustrated brochure from which some of the above details have been taken can be had on application to that address or from the Regius Keeper, Royal Botanic Garden, Edinburgh. This hearty recommendation, however, is not based upon the contents of the brochure but upon the recollection of several very happy days spent at Benmore in 1930 in company with Dr. Cowan.

R. M. G.

STUDIES OF SCOTTISH MOORLANDS IN RELATION TO TREE GROWTH.

By G. K. Fraser (Forestry Commission Bulletin No. 15), published by His Majesty's Stationery Office, Price 2s. 6d.

Although the occurrence of peat is not a problem which directly affects the Indian forester, there are points of very great value and interest to our readers in this bulletin, which we can recommend for careful study, particularly by those who have had the good fortune to visit the Scottish Highlands either for work or on holiday.

Compared with ordinary soils of mineral origin peat soils are organic, that is to say, they result from the accumulation of plant remains in areas where insufficient drainage, or the nature of the vegetation itself, excludes air and hinders the normal decomposition of these plant remains. Even where in India and Burma we have got the formation of peat going on in subtropical swamps, the conditions are

entirely the opposite of the Scottish Moorlands with their short growing season and severe wind, cold and exposure ; the deposit of potential peat is far heavier under subtropical conditions but the activities of the micro-organisms which reduce it are correspondingly greater. As an improvement upon the older continental classification of peats into *low moor* and *high moor*, and in contradiction of the older British notion that peat must of necessity be deep to constitute a planting problem, Dr. Fraser divides the British peats into *basin* and *climatic*, the first due solely to lack of drainage as in the English fens, and the second due to high rainfall and high humidity. This climatic peat forms the major silvicultural problem as it occupies a very large part of otherwise plantable moorlands throughout great areas in Scotland, Wales, North-Western England and Ireland. An interesting point is the very close relationship between the map of peat areas and a map of the combined effect of rainfall and humidity shown as a ratio figure of $\frac{\text{rainfall in millimetres}}{\text{rate of evaporation}}$.

The different kinds of peat are classified broadly according to the amount of decomposition which has taken place, the worst and most intractable being the fibrous kind in which lack of aeration, acidity and absence of decomposed plant food render tree growth either quite impossible or hopelessly slow even after expensive drainage has been carried out. On the better types of peat the trees which have done best are Sitka spruce and Norway spruce which although slow at first may often develop later through the gradual improvement of a plantation area through ditching, or dressing with basic slag which acts as an ameliorant in breaking down the gelatinous structure of the peat, leading to more suitable conditions for the bacteria whose presence is so vital for proper root development. The limiting factor most difficult to deal with is bad aeration, for even with mound or turf planting the roots of transplants are confined to a shallow top layer where of course they are subject to sudden extremes of moisture and temperature. Where the turf is deeper and more open in texture, the check in growth is not so obvious or so sudden, but such ground often shows a falling off in growth at a later stage. This has now been proved

to be due to the rapid growth of sphagnum moss around the roots in the partial shelter given by the young tree itself where, as so often happens in peat work, a considerable proportion of the plants fail from wind and frost and the survivors grow very bushy. Close planting is therefore advocated.

The rate of growth of trees on the various classes of peat has been studied and has been correlated with the actual herbage species amongst which the trees were originally planted, while the chemical values of the different peat types have been compared with the vegetation types occurring on them. Carefully graded plant lists have been prepared from which the gradations of the underlying peat can be readily recognised. The whole bulletin in fact is a testimony to the very practical value of detailed ecological study in correlating chemical and meteorological analysis with silvicultural results.

R. M. G.

EXTRACTS.

SHELLAC AND LAC PRODUCTS IN RELATION TO MODERN INDUSTRY.

By A. J. Gibson, F.C.H., F.L.S., Special Officer, Lac Inquiry,

India House, London.

(British Plastics Yearbook, 1933.)

In its 1931 and 1932 editions the British Plastics Yearbook published brief but excellent descriptions of shellac, its growth, production and manufacture. The scope of the present article is different but in order to secure a self-contained exposition of the processes of production as well as consumption, the following brief summary of what lac is and how it is produced will not be out of place as an introduction to a critical review of the situation created by advances in modern industrial practice and their effects on a natural raw material like lac.

Lac is the resinous incrustation of a small scale-insect living on certain trees. British India has a virtual monopoly of the trade in lac as the other sources of supply—Siam, Federated Malay States and French Indo-China—only produce, jointly, about 3 per cent. of the world's output.

Calcutta is the world's clearing house for nearly all the lac produced, amounting to 60-70 million pounds a year, collected from extensive tracts of country by large numbers of peasantry mostly in individual lots of a few pounds each. The United States of America normally take 50 per cent. of the annual export, the United Kingdom 25 per cent., and Germany, the remainder of Continental Europe, and the Eastern Hemisphere (principally China and Japan) the balance.

Subject to recent fluctuations, the gramophone industry absorbs 40 per cent., the spirit and water varnish trades, the polish and a variety of finishing industries and the electrical insulating trades 40 per cent., the hat and fabric stiffening industries 10 per cent., while the sealing-wax, pyrotechnic and a host of small industries utilise the remainder.

As lac is a natural product variation in quality and price characterise the trade. In order to overcome as far as possible these and other defects handicapping natural lac in competition with its synthetic rivals, the Indian Lac Research Institute, Ranchi, was established in 1925, and is engaged on lac research in all its branches, funds being raised by a cess (or small export duty) on all lac shipped from Calcutta. As a supplementary measure, a Special Officer, Lac Inquiry—to quote the official designation—has been attached to the staff of the High Commissioner for India in London since 1929, whose primary function is to study, and, if possible, to solve the problems surrounding the use of natural lac in the consuming industries and to extend these uses. The principal lac products are exhibited in a show-case always available for inspection at India House, Aldwych, and the Special Officer is glad, at all times, to receive and reply to, inquiries concerning the present uses of lac, or its possible utilisation, in all consuming industries.

A brief historical survey will suffice to recall the discovery of lac, and the sequence of events which led to the attainment of its present high status as one of the most interesting and important raw materials figuring in modern industry and international trade. Way back, as they say in America, two and a quarter centuries ago, a member of the Jesuit order, Father Tachard, published from India, the first account available to Western readers, of the interesting insect responsible for products now exported to the extent of 32,000 tons a year, with a value, in normal trading conditions, of over £3,000,000 sterling. Lac may, therefore, claim to be a very old member of the group of plastic resins. Subsequently, in 1781, Mr. James Kerr, of Patna, issued a Note dealing principally with the entomological aspects of the lac insect which throughout its history, in harmony with an idiosyncrasy by no means peculiar to although quite characteristic of entomologists and botanists, has suffered many changes in nomenclature, ranging through Tachardia, Coccus, Chermes, Carteria, Tachardiella, and Tachardina to its present designation of *Laccifer lacca* (Kerr). The supersession of its original description Tachardia can but be regretted on sentimental grounds if no other for it required no slight powers of observation on the part of that lonely priest-scientist in Pondicherry in 1709 to be able to record what he did, and it is a pity that the historical association should be broken and obscured by the change in name.

In 1804 Charles Hatchett published his " Analytical Experiments and Observations on Lac " in " Philosophical Transactions." The accuracy of the analysis then undertaken was remarkable, for Hatchett found in seed lac :—

Resin	..	..	88·50
Colouring extract	..	..	2·50
Wax	..	..	4·50
Gluten	..	..	2·00
Loss (moisture ?)	..	..	2·50
			100·00

while H. Schaefer in a paper published as recently as 1926 gave the following figures of *a fair average sample (decimals rounded off) :*

Moisture	..	..	2·0
Sugar proteins and soluble salts			4·0
Soluble dye	..	..	2·0
Wax	..	..	5·0
Resin	..	..	87·0
			100·00

These details also serve to emphasise the fact that lac is a very complex substance, more so in fact than appears from the above analyses, for the wax is a compound wax, one alcohol-soluble and the other alcohol-insoluble, while the resin is a mixture of substances of intricate molecular structure, principal among which is an alkali-soluble dye, a hydrocarbon, a substance giving shellac its characteristic odour, and two resins widely differing in constitution and physico-chemical behaviour. The fact that in shellac solutions one is dealing with a colloidal solution only further complicates the situation, while in bleaching lac the changes which undoubtedly take place are only most imperfectly understood.

The answer to the question " What is shellac ? " is consequently not an easy one to give and in view of the multiplicity of raw materials now available to industrialists in the plastics as well as other trades, due mainly to the active research of chemists in the synthetic resin field, it is manifest that research and research alone can ensure that lac products will remain in use in consuming industries now employing them and will find extended uses in industries at present in the nascent stage or in course of development.

As the sequel to careful and competent investigation, the authorities in India had the foresight to gauge the probable trend of events some years ago and consequently in 1925 the Indian Lac Research Institute at Ranchi was created with the object of practical research designed to improve and develop the cultivation, manufacture and marketing of Indian lac. The Institute is thus obviously concerned mainly with fundamental research and that in itself is a wide enough field, for the physico-chemical constituents of lac have to be determined and tabulated and as these vary from host-tree to host-tree (there are five principal host-trees), crop to crop and district to district, the work to be done is formidable. Add to this the indisputable fact that in India, under existing conditions in the lac industry, every stage in production, storage before manufacture, manufacture, storage after manufacture, packing and transport, is defective and has to be remedied in order to safeguard the future of the industry, and the task the Ranchi Institute has been set becomes trebly complex.

Yet modern conditions in regard to the supply of raw and semi-raw materials to industries are such that solutions to these difficulties have to be found, or lac is faced

with gradual extinction. The manufacturer of to-day has at his command so many raw materials that he is able to specify, and insists on close compliance with, stringent conditions in terms of stability and uniformity of qualities, and to some extent even of prices, and he demands and can secure, technical advice and service as required. In a word, it is an era of technically-prescribed buying specifications.

Mass production has produced another series of problems which also require solution such as the effect on materials of the speeding up of operations, the use of larger machines, heavier loads, more strenuous factors of operation, and increasing stresses under such heads as temperatures, humidity, resistance to solvents, oil, alkali and acid reactions. Only close co-operation between producers of lac and consumers, based on intensive applied research, can solve problems of this character. This research will be undertaken in the near future in the United Kingdom at the instance of the Indian Lac Cess Committee which controls the Indian Lac Research Institute, while in the United States of America, private research since 1928, financed by the principal lac importing firms in America, is already, it is understood, producing useful results which however very naturally are disclosed only to the subscribing firms, and are not available to distributors and manufacturers generally.

Research on lac in relation to the consuming industries has therefore to be focussed on definite lines in order to adapt the products to modern conditions and requirements. A skeleton programme would include the following items :—

(*a*) (*i*) A critical study of the effect of heat treatment, with a view to finding means to enhance the mechanical strength and increase resistance to softening and deformation at temperatures met with in electrical practice.

(*ii*) Improvement of thermo-plastic properties.

(*b*) The exhaustive study of the theory and practice of bleaching shellac and the obtaining of standard and permanent qualities. The obtaining of light coloured shellacs by other means would be part of this research.

(*c*) Research into esterification and other chemical modifications of shellac to produce new substances with alternative properties. Private research has shown that lac-esters have properties which are valuable.

(*d*) Research into the di-electric qualities of lac.

(*e*) A critical study of shellac films in decorative and protective finishes for wood and other surfaces, together with a study to determine the correct plasticisers, etc., to enhance the water and weather resistance.

(*f*) General investigations into the improvement of the technique of using shellac in industrial operations and the development of processes designed to utilise shellac in place of competing substances. This work comes within the term "Chemical Engineering," and requires a study and knowledge of plant design and construction methods.

(*g*) Work designed to discover or develop new uses :

(*i*) Shellac adhesives.

(*ii*) Shellac solutions as a vehicle for pigments.

(*iii*) Shellac protective paints for oil tankers. This is a very pressing problem.

(*iv*) Extending the scope of shellac alkali water solutions.

(*v*) Compilation and publication of exact data on the physical, chemical and mechanical properties of shellac, with special reference to use in industrial processes.

The successful execution of such a programme would go a long way to consolidate the position of lac as a raw material in industry. But lac has its limitations and consequently the following extract from a recent paper by Mr. H. V. Potter, B. Sc., F. I. C., in " A Survey of the Plastic Industry " reprinted in " The Journal of the Society of Chemical Industry," dated October 21, 1932, may have an important bearing on the future of lac as well as synthetic materials suffering from disabilities of a similar nature. Mr. Potter says that " future developments are more likely to follow on the lines of designs and construction being entirely controlled by the properties of the materials themselves. In other words, plastics have in many cases been adapted to meet existing conditions where they could. The future will depend on design being built round the special properties of plastics and the tendency to-day is in this direction."

This is a heartening outlook and if the Indian producer will guarantee to market his lac in the consuming markets in as fresh and unadulterated a condition as possible, the research workers in the United Kingdom and elsewhere may be left to extract the maximum advantage and utilisation from a natural product so processed.

Finally, two assertions may be hazarded which are equally beyond challenge. The first is that scientific research, carefully concerted and tirelessly pursued, is as vital to the preservation and continued improvement of raw materials, such as lac, as of their synthetic alternatives. The second is that, despite the ineradicable British habit of self-depreciation, in no country is industrial research better organised, or productive of more solid and useful results, than in the United Kingdom. In his Norman Lockyer lecture at the British Science Guild on November 23, 1932, Sir Frank Smith, secretary of the Department of Scientific and Industrial Research, after adducing evidence of the rapid growth of co-operative industrial research in this country, quoted two American opinions on the value of British research as applied to the steel industry. Dr. Arthur Little, of America, has declared : " The entire structure of the iron and steel industries would collapse if the contributions of British metallurgists were withdrawn." And Mr. Schwab, the great American steel magnate, who last October received the Melchett medal of the Institute of Fuel, said on that occasion : " Every great process in the manufacture of steel has come out of Great Britain." Similarly, as Sir Frank Smith claimed, in the engineering, chemical, textile and other industries, this country has contributed knowledge which, in the aggregate, is not equalled by any other country.

So fine a record of practical achievement may fairly be regarded as of good augury in the event of comparable effort and talent being applied, even at this late stage, to the problems inherent in the efficient production and marketing of lac, and its appropriate utilisation by the great consuming industries whose continued and undiminished support is not merely desirable, but vital to its survival.

BURMA FOREST SCHOOL PRIZE DAY.

The annual prize distribution of the Burma Forest School—the 23rd since the establishment of the School in Pyinmana—took place in its main hall on the morning of Wednesday, 3rd May.

The Hon'ble Sir J. A. Maung Gyi, Forest Minister, was unfortunately unable to attend owing to the extended session of the Legislative Council in Rangoon and Mr. Hopwood, M. C., Chief Conservator of Forests, Burma, presided.

The Chief Conservator was accompanied on the dais by the following officers:—

Messrs. N. V. Holberton, Conservator of Forests, Chindwin Circle, R. E. McGuire, M.A., I.C.S., Deputy Commissioner, Yamethin District, A. F. R. Brown, M. C., Deputy Conservator of Forests, Mandalay Depot Division, R. J. Sayers, Deputy Conservator of Forests, Pyinmana Division, and W.G. Crawford, Deputy Conservator of Forests and Director of the School.

Guests from the town and out-stations and students looking very smart in green gaungbaungs and pasoes and khaki jackets, filled the body of the hall.

Mr. Crawford said:—

Mr. Hopwood, Ladies and Gentlemen,—Before giving you a brief account of our work of the past year, I wish on behalf of the School, to express our regret that the Hon'ble Minister for Forests has been unable to honour us with his presence; Sir Joseph Maung Gyi has been a very good friend of this school for many years and it would have given us great pleasure to welcome him here.

The Forest School was founded in 1898 as part of the Tharrawaddy Forest Division but was separated from that Division and moved to the present buildings in Pyinmana in 1910. This is the 23rd Prize Day in Pyinmana.

Thirty-three students complete the courses to-day. The Upper or English Class consists of nine students from Burma and two from Siam. This Upper Class originally started the two year course in May 1931 with twelve students but one was removed during his first year. Of this Upper Class six have obained the Honours Certificate and five the Pass Certificate. The men from this Class go out to Divisions as Probationary Rangers, and if found satisfactory at the end of two years are appointed as Rangers with good prospect of promotion to the rank of Extra Assistant Conservators of Forests.

The Lower or Vernacular Class, which is the first to pass through the School under the New Reduced Vernacular Course, started in October 1931 with 26 students. Unfortunately four students had to be removed during the course, one as he was unfit for strenuous jungle work and three for failure to pass the Periodical Examinations. Of the twenty-two who complete the course to-day, five have obtained the Honours Certificate and 17 the Pass Certificate. The Vernacular Class men pass out of the School as Deputy Rangers with good chances of promotion to the Ranger Grade.

The usual seven and a half months of the year have been spent on tour and while on tour the work done by the students briefly was:—Girdling of teak over two compartments, improvement fellings in three compartments, thinning of about 100 acres

of teak plantations, the building of a bridge with a span of 30 feet, several large scale surveys and various minor works such as weedings in young plantations, road alignment and road repairs and repairs to compartment boundaries. During the rains students visited U Ba Oh's saw mill at Sabein and River Training Works being carrried out by Messrs. Steel Bros., Ltd., on the Sinthe Chaung. Our thanks are due to U Ba Oh and to the Manager, Messrs. Steel Bros., Ltd., Pyinmana, for their kindness in allowing us to visit these works. I should also like to thank U Sein, late Township Officer, Pyinmana, for so kindly making arrangements in August last for students to see an actual Prosecution under the Forest Act in his court.

It was fortunately found possible to give the 2nd year classes two short tours in November—one to Mandalay, the other to North Toungoo Division—and I think that the students have considerably benefitted from these tours. In Mandalay the students spent four days doing field engineering with the 14th Field Company, Queen Victoria's Own Madras Sappers and Miners, and we are very grateful to Captain Searight and the officers of that Company for the very interesting programme they worked out for us.

The School Football XI had a very successful season. Out of twelve outside matches played, we won nine, drew two and lost one. After three hard and cleanly fought struggles we managed to win the Kiernander Cup from the Provincial Police Training School, Mandalay.

In addition to football, basketball, hockey, athletics and the champion section competitions kept every one busy during the rains term. Saw Sein Ba and Maung Toe Maung are to be congratulated on setting up a new School Record of 5′-4″ for the high jump, and Saw Tha Htin in winning the Marathon Race of about 12 miles in 1 hour 23 minutes put up a very fine show especially when it is considered that he had been at the School only a month.

After the address had been translated into Burmese by U Po Mu, Extra Assistant Conservator of Forests, an Instructor of the School, the certificates, medals and prizes were distributed to the outgoing classes by Mr. Hopwood.

In the afternoon a pagal gymkhana was held in the school grounds commencing at 4 p.m., and the staff were "At Home" to their guests. As usual large and enthusiastic crowds turned out to watch the various items on the programme of what is fast becoming one of the most popular events of the Pyinmana year.

True, this year no greasy pole with a ten rupee note tied to the top raised its glistening length in the air to tempt optimistic treasure hunters from the crowd to add their grease to its surface in vain endeavours to attain affluence. But these are days of financial stringency and notwithstanding the fact that on no previous occasion has any climber been able to reach the top, ten rupee notes are too few and far between for any risk to be run.

There was also no pillow fighting on a pole precariously placed over a trench of muddy but none the less cool and inviting water ; for water is scarce in Pyinmana at this time of the year. The staff, however, endeavoured to make up for this lack of

liquid, by erecting a tent in one corner of the grounds from whose dark depths the chink of ice and hiss and splutter of opening soda water bottles struck a welcome note.

Three clowns, one dressed—or rather undressed—as a Zulu warrior kept the juvenile portion of the crowd amused with their antics and juggling, but it was the children themselves in a children's race that provided the most laughter. Of the various events the hut building and tent pitching were probably the most spectacular. The sack scrimmage and the tug-of-war between teams of 1st and 2nd year students were both won by the seniors.

It only remains to state that few of the guests could have been aware by how narrow a margin tragedy was averted, and what a depth of gratitude everyone owes to Mrs. Edgerley and Mrs. Johannes who so ably dispensed hospitality. The cakes and refreshments ordered from Rangoon failed to arrive and consternation confounded the faculties of the Director and Staff! These two ladies calmly stepped into the gap and baked and prepared everything within three short hours' notice! No one could have guessed this from the quantity and quality of the refreshments provided. In fact their efforts have been so appreciated that the staff have decided to rely on them always in future, and never again on outside confectioners. Thus is merit rewarded.

(*The Rangoon Times, May* 7, 1933.)

REPORT OF THE IMPERIAL INSTITUTE FOR 1932.

Timbers.—Hitherto the trade in Empire timbers has been handicapped by the absence of clearly defined grading rules and specifications of sizes. A Sub-Committee, to which have been co-opted overseas forestry officers on leave and representatives of the Dominions and India, has been set up to deal with this question, and considerable progress has been made in the drafting of standard grading rules and sizes for Empire hardwoods. In this work the Committee are acting in co-operation with the Technical Committee (on which the Timbers Committee is represented) recently appointed by the British Standards Institution to implement the recommendation of the Imperial Economic Conference at Ottawa (1932) in regard to the formulation of standard specifications for timber.

The assistance of the Committee in handling a test consignment of sawn *meranti tembaga* timber (*Shorea leprosula* Miq.) on the London market was requested by the Director of Forestry, Federated Malay States and Straits Settlements. Examination of sample planks of the timber, which would have to compete with Philippine *lauan*, created a favourable impression, and a trade member of the Committee offered to purchase a commercial consignment to test the London market. The offer was accepted and the timber, which has recently arrived, has proved entirely satisfactory. Development of the trade depends upon the extent to which timber free from defects (" worm ") can be profitably exported from Malaya. Information as to the sizes and grading of *lauan* imported into this country was furnished to the Director of Forestry. Enquiries are being made in regard to the market prospects in London of another Malayan timber, *keruing* (*Dipterocarpus cornutus* Dyer), a counterpart of Philippine *apitong*. In both these investigations the Committee has been in consultation with the Deputy Director of Forestry while on leave.

The possibilities of obtaining Empire substitutes for the foreign supplies of *balsa* wood, a very light timber used for insulation and other special purposes, is being considered. Series of light timbers submitted by the Forestry Departments of Sierra Leone and the Gold Coast, and Indian *balsa*, have been examined, but none could be regarded as a satisfactory substitute for Guatemalan *balsa*.

[See extract on page 589 of *Indian Forester* for October 1932.—ED.].

The Committee are making enquiries as to Empire woods suitable for veneer cutting, more especially as alternatives to the foreign Gaboon mahogany extensively imported for the purpose.

At the request of the High Commissioner for New Zealand the commercial prospects of New Zealand white pine (*Podocarpus dacrydioides* A. Rich.) in this country have been considered. The future of this excellent timber depends upon the price at which it can be offered.

Other work dealt with or in hand includes enquiries as to Andamans timbers for the United Kingdom market; the market for selected Fijian timbers; Gold Coast *danta* wood for axe and tool handles; fire-resisting qualities of Empire timbers; and Burma *pyinkado* as a flooring wood.

Sunn Hemp.—In continuation of the investigation of samples of Indian *sunn* hemp with a view to determine the effect of the duration of retting and other factors on the quality of the fibre, reports on the examination of further specimens from the Central Provinces were submitted to the Committee together with general conclusions based on the results of the whole of the work (involving the examination of 358 samples), and these were subsequently transmitted to India. The report on "Hemp Marketing in India," prepared by the expert appointed by the Imperial Council of Agricultural Research in India, was carefully considered by the Committee and their observations and suggestions were communicated to the authorities in India. The Committee are of opinion that in order to improve the *sunn* hemp industry, co-operative effort will be required between the three sections of the industry, *viz.*, (1) cultivation and preparation in India, (2) marketing and shipping at the Indian port, and (3) reception and distribution of fibre in importing countries, and they are accordingly taking steps with a view to the promotion of such co-operation.

Tung Oil.—The Sub-Committee on *Tung* Oil has continued its work of encouraging the production of *tung* oil in the Empire and the investigation of cognate technical problems. Experimental cultivation trials have now been in progress for several years in many countries, and in some cases the trees have commenced to bear fruit (see *Bulletin of the Imperial Institute*, 1932, No. 1). Plantations of *Aleurites fordii* on a commercial scale have been, or will shortly be, started in Burma, Assam, Australia and New Zealand. The results of the examination of samples of *tung* fruits, seeds and oil produced in various parts of the Empire were published in the *Bulletin of the Imperial Institute* (1932, No. 3), and show that the oil is equal in quality to the best Chinese and American oil.

[An account of the Shan States plantations will appear in our September issue.—ED.]

In order to elucidate problems connected with crushing and extraction, a consignment of *tung* seed was purchased from America and a series of experiments carried out at the works of one of the large firms of oil-crushers. Feeding trials on poultry, dairy cattle and pigs with the meal obtained in the above experiments have been conducted at the Rowett Research Institute, Aberdeen (with the aid of a grant from the Empire Marketing Board) in order to determine whether this material can be safely employed as a feeding-stuff for animals. The results indicate that the meal will have little value for this purpose on account of its unpalatability.

Lac.—At the request of the High Commissioner for India the Committee considered questions relating to the utilisation and marketing of Indian lac, the demand for which is being adversely affected by the increasing use of artificial resins. A Sub-Committee which was appointed to advise as to the steps required to maintain and extend the industrial applications of lac submitted a report strongly advocating a scheme of applied research on lac in the United Kingdom in close touch with the consuming trades as the only effective means of meeting the competition of artificial resins, and proposing that funds should be raised for this purpose and also for propaganda, by increasing the cess levied on lac exported from India. The Sub-Committee emphasised the importance of taking action without delay and their recommendations have been supported by the London Shellac Trade Association. The Lac Cess Committee in India has approved an increase in the cess for the purpose of providing funds for research on the industrial uses of lac both in the United Kingdom and the United States, and a scheme is to be put into operation at an early date.

Tanning Materials.—The Committee had under consideration the results of the investigation carried out at the request of the Natal Wattle and Timber Growers' Association, with the approval of the Forestry Department, Union of South Africa on the tanning value of the bark from green wattle trees (*Acacia decurrens* at various stages of growth in comparison with that from black wattle, (*Acacia mollisima*) the tree which provides the Natal bark of commerce. The suitability of immature bark for extract-making was also concerned. These problems are of special interest to the Natal wattle bark industry in view of the relative immunity of the green wattle tree to bagworm, the pest which is a serious menace to the black wattle tree. The recommendation was made that an investigation of samples on a more comprehensive scale was desirable in order to obtain the information necessary to justify definite conclusions.

Attention has been given to the possibility of increasing the supplies of gambier of reliable composition from Empire sources, and the subject has been brought to the notice of countries likely to be interested. Tanners using the material would welcome supplies from within the Empire to replace the present imports from foreign countries. The production of adequate supplies of gambier at a suitable price would permit of a greatly extended use of the material, which is recognised as a tan stuff possessing valuable properties.

Woods from Trinidad for Paper-making.—At the request of the Forestry Department in the Colony, experiments have been carried out to determine the value of a number of local woods for paper-making, and during the year under review reports were furnished on the following species: *jiggerwood* (*Bravaisia floribunda* D. C.), *bois mulatre* (*Pentaclethra filamentosa* Benth.), and *mahoe* (*Sterculia caribaea* R. Br.). The samples gave good yields of pulp, the best results being obtained with the *mahoe* wood, the pulp of which was also longer-fibred than the others and produced a rather better paper. The papers produced from the *jiggerwood* and *bois mulatre* pulps were similar in character, and resembled those obtained from some commercial soda pulps. In general the bleached pulps prepared from the three woods would be suitable for the manufacture of book and printing papers. The fibres in each case had a rather higher average length than those of pulp made from aspen, which is the hardwood most commonly employed in the manufacture of soda pulp.

Gelam Wood from Malaya for Paper-making.—This sample of *gelam* wood (*Melaleuca leucodendron*), of which considerable quantities were stated to be available, was forwarded by the Forestry Department for examination as a source of paper pulp. It was found to yield a short-fibred pulp composed of fibres of similar length to those of broad-leaved woods such as poplar, but the yield of unbleached pulp was considerably less than that obtained at the Imperial Institute from poplar wood when treated under similar conditions. The poplar pulp was, moreover, much easier to bleach than that from the *gelam* wood. The *gelam* pulp felted well and yielded fairly strong paper, rather similar in character to that obtained from poplar or aspen pulp, and it would be suitable for use as a substitute for the latter in the manufacture of book and writing papers. It is, however, doubtful whether *gelam* wood could be remuneratively employed as a paper-making material owing to the low yield of pulp and the difficulty of bleaching, whilst even if the pulp were produced in Malaya it might not be possible to ship it profitably to the United Kingdom, and an outlet would probably have to be found for the pulp in the East.

Insecticidal Plants.—Nearly fifty enquiries relating to plants which can be used in the preparation of insecticides were received. Most of these had reference to products already well-known in commerce such as *Pyrethrum* flowers and *Derris* root, whilst others were concerned with materials not as yet on the market, including the African *Tephrosia vogelii*, *haiari* of British Guiana and *cube* of South America. Supplies of *Pyrethrum* flowers have hitherto come from Japan and Dalmatia and production in the Empire is very desirable. Information as to the cultivation, preparation and marketting of *Pyrethrum* has been supplied to planters, particularly in Kenya, where production on a commercial scale has already commenced, and also in Nigeria, India, Ceylon and British Malaya. Seed of selected strains has also been furnished to planters in Kenya for trial cultivation. *Derris* is produced on a commercial scale in Malaya, and enquiries have mainly been concerned with putting firms in this country and elsewhere in touch with suppliers. Firms of manufacturing chemists have been furnished with particulars regarding rotenone, the active principle of *Derris* roots.

Rattans.—Enquiries had been addressed to the Forestry Department, North Borneo, by dealers in jungle produce regarding the possibility of making direct shipments of rattan canes to England from the Territory. The Forestry Department consulted the Imperial Institute as to the feasibility of the proposal and forwarded six samples of the canes for inspection. The specimens were submitted to a firm of importers and dealers who expressed their interest in the project and reported that the canes were of useful quality. In order to obtain a better idea of the material that would be available commercially from North Borneo they arranged to purchase a small consignment of the most promising kinds. The firm pointed out that an important matter in establishing a trade in these rattans would be that of supervision of packing, to ensure that parcels would consist wholly of canes of the proper variety and quality. The Forestry Department accordingly agreed to undertake the supervision and packing of the rattans and issue certificates as to quality, quantity and species concerned. The trial consignment was subsequently received in London, and as a result bulk samples of two selected kinds of the rattans were ordered so that they could be given a thorough trial.

Producer-Gas for Motor Fuel.—Articles in the *Bulletin of the Imperial Institute* giving the results of work carried out on wood charcoal from British Guiana and Kenya, as a fuel for producer-gas-driven motor vehicles, led to enquiries for plant for utilising such fuel from the Government Industrial Institute, Madras, and the Department of Commerce and Industries, Baroda. The enquirers were referred to a British firm who could supply the attachments necessary to adapt a petrol-driven lorry for the use of producer-gas. Later, at the request of the Conservator of Forests, Sierra Leone, a detailed statement was compiled, describing the various types of plant available and any difficulties likely to be encountered in their use. A résumé of this information was subsequently published in the *Bulletin of the Imperial Institute*, 1932, 30, 469-479.

INDIAN FORESTER,

OCTOBER, 1933.

THE STUDY OF FOREST SOILS.

We welcome a contribution in this number from the pen of Dr. C. S. Fox of the Geological Survey, and we feel sure that many of our readers will find his lucid explanation of laterite soils of very great value, whether or not they have read the Imperial Bureau of Soil Science pamphlet which Dr. Fox has so kindly undertaken to explain in less technical language than is used in the original pamphlet.

A very large amount of literature has appeared during the last two years on the subject of soils, but most of this is confined to the agricultural point of view and to temperate climates. Although silvicultural knowledge can to a great extent be used empirically in applying what has been learned in the temperate zone to tropical conditions, this is far from being the case in soil studies, but the important differences between temperate and tropical soils are only gradually being realised. Many general principles valid for soils of temperate climates cannot be transferred to torrid zone soils. Failure to realise this has given trouble to many planters, for instance many soils of the red earth class which covers so much of the tropics contains practically no calcium carbonate and if dealt with on the basis of temperate agriculture would need an addition of lime. In point of fact however for crops such as tea this class of soil often contains too much calcium and has to be acidified artificially. Again we have the fact that tropical soil changes far more rapidly than do temperate soils, so that simple working and aeration of acid soil in the tropics produces big reductions in acidity, whereas in temperate climates such changes are almost unknown. A most valuable contribution on tropical soils is H. Greene's English translation of P. Vageler's "Introduction to Tropical Soils" (McMillan, 1933, 15/-) which incorporates

recent work in Java and the Sudan on the various planters' crops as affected by tropical soil conditions; it emphasises the great dangers of soil exposure under any form of cultivation and makes frequent reference to the role of the forest in the building up of tropical and subtropical soils, thus bringing into focus the extent to which agriculture is dependent upon the forest for its well-being. We can thoroughly recommend this book to all who are interested in this fascinating subject.

Much of the tropic and subtropic red earth soils which have often been wrongly called laterites are to outward appearance devoid of humus. This is largely due to the bright colouring imparted by iron compounds which disguises the dark colouring that temperate experience would immediately associate with the presence of humus. Actually the humus content is generally quite high, especially in regions of heavy rainfall, and its preservation by careful cultivation is more than ever essential in view of the increased dangers of erosion and leaching by the heavy rain. Artificial replacement of this humus content by means of green manuring by the growing and digging in of leguminous and other crops is becoming commoner, while in the case of cinchona and coffee, and possibly of many forest trees, the mycorrhiza so necessary for the crop's full growth can only develop in the presence of humus. Again the rapid alteration in the chemical and physical features of tropical soils by the intensity of weathering is emphasised by the absence of any resting period such as temperate soils enjoy during a long winter when they are chemically inert. The tropical planter must think in terms of single years while his confrere in the temperate zone deals in decades or even centuries. The mineral part of a soil which in colder climates is little more than the skeleton on which the active soil is built, becomes in the tropics and subtropics a constant reservoir of plant foods and of the soil colloids which carry these foods and help to make them available to the plant. It is thus obvious that the planter must know more of the chemistry of the various minerals which go to build up his soil if he is to be successful in the hotter climates, and when we talk of planters we naturally include foresters. It has often struck us as an anomaly that foresters

should know so much of what happens to a tree above-ground and so very little about the below-ground part of its life, for although the tree derives most of its nourishment and all of its stability from the soil, research in forest soils, and particularly in the tropics and sub-tropics, is lamentably small. Detailed soil analysis can of course only be done by laboratory workers, but a working knowledge of soils is more easily acquired by the outdoor man than is usually admitted. In the case of the great stretches of laterite soils which occur in South India and Burma, the chemical composition is reflected clearly by the vegetation and a more thorough correlation of the soil chemistry and natural vegetation may prove of enormous value. Vageler states that 75 per cent. of all failures of crops is due to the choice of unsuitable land, for many tropical agricultural crops will not grow at all unless the soil has certain well defined properties. In the case of forest plantations the choice is doubly important, for failure in quality class may cause serious financial loss many years after a plantation has been apparently successfully established. To avoid such failures the forester must " pick the brains " of the geologist and the soil chemist, then attempt to correlate what he has learned from them with what he finds on the ground.

To appreciate the value of the latest information which Dr. Fox gives about laterite, a few general observations on soil formation may be of use. The early attempts of soil workers to correlate the occurrence of certain soils with climatic changes have recently been rendered more accurate with the realisation that we are dealing with two climates, *air climate* and *soil climate*, the latter being the product of air climate plus other local conditions such as the weathering of the parent rock and the water logging of the soil. Moisture and temperature conditions within the soil must influence soil formation and soil processes to a far greater extent than conditions outside the soil. Hence within the two great air climatic zones of the permanently humid tropics and the periodic drought and rainfall of a monsoon climate we have many local sub-divisions governed by those other factors. The daily temperature variation of a forest-covered soil in the wet tropics is very small indeed, whereas bare soil in the same air

climate may show a range of 60—80 degrees Centigrade; this larger variation has an overwhelming influence on the movement of soil water. This explains the markedly deleterious effect which the ill-considered clearance of forest so often has upon the soil. The fierce radiant energy of the direct sun not only destroys the microflora in the surface layers but the humus is literally burned up and reduced to a sort of oxidised charcoal dust which is rapidly removed by rain and wind. The local soil climate is therefore largely determined by the presence or absence of a shade covering of vegetation.

Some confusion is apparent in the use of the term "soil profile," the spacial arrangement of the various soil layers which can be separated according to colour etc. in a vertical section. These layers have a two-fold origin, firstly, the *beds* in which the soil was originally formed either by weathering of the parent rock *in situ* or by deposition of water-borne soil or volcanic ash, and secondly, the *horizons* which are distinct layers produced within the bedded material by chemical or physical changes. Bedding is connected with climate only in so far as the depth and size of grain is governed by the rainfall, but horizons are directly dependent upon the local soil climate. Chemical and physical changes are governed largely by the vertical movement of moisture, which is predominantly *downward* only where the soil climate is such that the amount of water introduced by rain or surface drainage exceeds the amount removed by evaporation, obviously a not very common condition. Elsewhere the movement may be seasonally upwards or downwards as in most monsoon climates. The accompanying chemicals may thus carry plant food either upwards or downwards. The layer losing soil material is the *eluvial* horizon and the products of decomposition often have a far-reaching effect on the *illuvial* horizon in which they come to rest.

In the building up of most forest soils it must be remembered that under no conditions could evergreen tropical forest have been the original soil-forming agent. The process of building a soil even under tropical conditions is a slow one and thousands of years must pass while the red soils of the tropics are being built up from the parent rock and prepared by an ascending series of plant associations of grass,

herb and scrub jungle for the climax type of evergreen forest. As a consequence red soils often of great depth are first formed wherever humidity is sufficient, and the final development of their horizons is a function of the increase in humus substances following an increase in plant cover. For centuries before the establishment of dense forest cover there is ample opportunity for rain and air to penetrate deep, taking away with them the exchangeable bases and silicates from the upper eluvial horizon, which becomes comparatively richer in the less easily removed iron and aluminium. With the establishment of dense forest the amount of humus steadily increases and with it a much more definitely acid reaction, especially where the bases have already been leached out. So long as the acid action is not too strong the humus continues to manufacture colloidal gel complexes and these are deposited in the layer of soil immediately adjoining the humus layer—the illuvial horizon which forms the reservoir of plant foods wherever tropic or semi-tropic forest is cleared for cultivation. Once the cover has been removed, however, this reserve of plant food is only too easily dispersed by active erosion, or is rendered unfit for further planting by the hardening of the unprotected surface by leaching.

The decomposition of mineral matter in the case of laterite soils occurs in three stages, namely :—

raw materials —> kaolin or lithomarge (china clays) —> laterites. The first change is met when the ratio of silica to alumina remains around 2 : 1. With further decomposition the ratio becomes narrower and theoretically may end in 0 : 1, when all the basic silicates have been leached out. A 2 : 1 ratio is accepted as the limit between the common red soils and the true laterites. The laterites beginning under 2 : 1 may sometimes reach the ratio of 0 : 1 where the supply of silica has been entirely leached out.

Though low in plant nutrients soils of a lateritic type respond well to cultivation largely where their favourable physical properties are taken advantage of by adding green manures. A large portion of the tea grown in North-East India and around Ranchi is on lateritic

soil, as is much of the sugar in Bombay Presidency and the mangoes and cashew nuts of Goa. The forest species which do well on laterite have been enumerated by Troup (*Silviculture of Indian Trees*, page xxxvii) but the only thorough local soil investigation where forest is associated with laterite, so far as we are aware, is Barrington's work on the correlation of the soil texture index and herbaceous flora with the growth of teak and dipterocarps on the *indaing* soils of Lower Burma (*Indian Forester*, LVIII, 1932, pages 547—555).

LATERITE AND LATERITE SOILS.

Note on Technical Communication No. 24, 1932, *of the Imperial Bureau of Soil Science, London, by Dr. C. S. Fox, D.Sc., M.I.Min.E., Superintendent, Geological Survey of India.*

In elucidating this pamphlet it is necessary first to define what is meant by the term laterite. In the words of Dr. L. L. Fermor* ' This rock consists essentially of a mixture of hydrated oxides of iron and alumina, with often a considerable percentage of titania.' An absence of silica, either free as quartz or combined as lithomarge, is a characteristic of true or primary laterite formed *in situ*. It is this kind of laterite which is the parent rock to all other kinds and it is of this *in situ* laterite to which Dr. Fermor's definition strictly applies. Occasionally *in situ* or primary or high-level laterite, using synonymous terms, may contain appreciable amounts of other constituents than the two main lateritic components—ferric hydrate and aluminium hydroxide. These give a clue to the rock from which the laterite has been formed or indicate whether the laterite is primary or secondary (detrital) in character.

Lateritisation.—Laterite is now well known to be the residual weathering product of various rocks—dolerites, basalts, granites, shales, felspathic sandstones, etc.—which contain aluminium and iron among their constituent minerals. The process of weathering is not quite clear, but is evidently associated with monsoon conditions—

* What is Laterite ? *Geological Magazine*, December 5, VIII, pages 454—462, 507—516, 559—566, (1911).

—alternating dry and wet periods—whereby water, perhaps charged with atmospheric acids, both enters and drains away from the rock which has been rendered porous. These waters remove all the alkaline components—lime and magnesia and of course the alkalies—soda and potash—and in a selective manner also the silica which was originally present in the rock silicates. Free silica, as quartz in granites and felspathic sandstones, is evidently not so readily dissolved. In process of time the exposed rock, usually on an elevated tract, is weathered to a depth of 30 to 40 feet and in the upper 20 to 25 feet only trifling amounts of original silica are left, while the whole of this leached sub-surface zone has more or less the composition indicated by Dr. Fermor.

It is evident that the main mass of the rock remains and that the material removed has gone in solution or perhaps partly in suspension. The volume of the rock is if anything larger than it was before weathering so that the porous character of the laterite is expected. In actual fact the rock is scoriaceous in aspect and vermicular in structure, due to the many tubular cavities it often contains. The colour is red to grey, but mostly mottled in these two colours, the one due to hydrated iron oxide and the other the result of segregations of aluminium hydroxide. *During the rains the water entirely fills the pore spaces in the laterite, but in the dry season the waterlevel falls until in the hot weather the ground water may be* 25 feet *below the surface.* The soil on laterite plateaux is generally red, but sometimes yellow, and of a non-plastic kind of clay rich in iron (ferric oxide and limonite).

Like other rocks, the *in situ* laterite suffers erosion, and blocks fall away along the edges of scarps. This *débris* is washed down and may accumulate as a terrace at the base of a hill slope or be spread out to cover large areas of lowlands. As may be expected this detrital material will become mixed with other rock *débris* including sands and gravels of quartzose substances. These can be readily seen in so-called low-level or secondary laterite, as the detrital material is sometimes called. A curious feature of this lateritic *débris* is the property the material possesses for becoming consolidated in a rock-like mass. In fact large spreads of low-level laterite in the Carnatic and the South Mahratta country are solid by this mode of agglomeration.

While damp, all types of laterite are relatively soft and easy to cut into blocks, but after quarrying and on exposure to the air, these blocks slowly lose moisture and the material becomes hard.

From what has been said it is seen that the parent rock (high level laterite) is of a remarkable composition. It is also of a curious mode of formation evidently peculiar to tropical regions subject to alternate dry and wet seasons. It is associated with elevated land and is usually found capping plateaux of basaltic lavas in the peninsula. It is also found on other rocks. The *débris* from the original laterite reconsolidates in lower ground and is often recognisable by the quartz and other material mixed with it. A vermicular structure (texture), a mottled appearance and perhaps a ferruginous scoriaceous aspect are common to both *in situ* and detrital laterite, but there is less uniformity of composition in the former. Large grey segregations of highly aluminous laterite on the one hand or rich ferruginous coverings on the other hand are often met with in primary laterite occurrences. Also the rock itself may frequently have a pisolitic texture—in the grey, the normal or even the highly ferruginous varieties of *in situ* laterite.

Now, seeing that the mode of formation of laterite (*lateritisation* as we prefer to call it rather than *laterisation*) is one of intense leaching of a hydrated rock, it follows that practically all the soluble constituents have been removed. Only the most insoluble components are left—hydroxides of iron and alumina. And the mass is exceedingly porous but none the less consolidated. So far as the Indian peninsula is concerned, plateaux of primary laterite are generally open, rolling, grass country with occasional clumps of forest—the trees spaced and having little undergrowth. In the early months of the year these plateaux are rather desolate and water is hard to find on the top, though springs occur below the scarp at various points. Large laterite plateaux are in fact great store-houses for water from perennial springs along the base of the scarps.

It has been said that the depth of primary or *in situ* laterite may be as much as 25 to 30 feet. Below this there is for another 10 to 20 feet, perhaps, a zone of deeply altered rock—generally kaolinised.

In most occurrences of primary laterite and in many secondary laterite deposits there is, at its base, a layer of white or pinkish or sometimes yellow clay. This clay is fine, soapy and plastic, and may be 15 feet thick in places, but is usually 3 to 5 feet with wavy banding. This is true lithomarge ; and the white material is suitable as a fuller's earth. It is this layer of clay, evidently formed while the laterite was forming, under the mantle of laterite and above the kaolinised rock on which it rests, that acts as an impervious stratum and prevents the water in the laterite from sinking down indefinitely. When a laterite mantle is eroded, this underlying lithomarge and the zone of kaolinised rock is exposed, and is sometimes, but erroneously, referred to as laterite because of its mottled colouring and pseudo-lateritic appearance. However, it is not lateritic in composition—averaging over 30 per cent silica.

Climatic and Geological factors affecting Lateritisation.—As has already been stated, true laterite such as is met with in India, the Malay Peninsula, Western Australia, East and West Africa, Brazil and the Guianas, appears to be restricted to tropical countries. However, true laterite has been found in Hesse, Germany, and it was this material which was compared with the Seychelles laterite when it was suggested that laterite and bauxite were the same. As the Hesse material is laterite and not the same as the bauxite of France, Istria and the Adriatic region which is associated with limestone uplands and thought to be derived from these limestones, it is wiser to maintain the double nomenclature. However, even in the case of the German laterite it appears that at the time of its formation (in Upper Miocene times) the climate of the Vogelsberg was tropical to subtropical. The Indian laterites date from a still earlier period—the Lower Eocene—and tropical conditions certainly appear to have prevailed then. All the evidence goes to favour the view of alternate dry and wet seasons rather than merely heavy rainfall. But it is difficult to gauge from present day conditions occurrences of laterite of 30 or more million years ago. This is true also of the temperature, but as stated a warm climate is indicated by the evidence. It is not to be forgotten that the rock must be suitable for lateritisation.

It need hardly be pointed out that such rocks as limestones and sandstones and quartzites cannot yield as a residual weathering product material of the nature of laterite. Nevertheless, laterite is found resting on or otherwise associated with such rocks. The explanation must be sought by detailed examination of the occurrence, but in most cases it is found to be a reconsolidation of detrital laterite brought from nearby. In the case of sandstones there is often an infiltration of limonite or ferric hydroxide into the joints of the rock and the sandy material between falls out, leaving a honeycombed mass of ferruginous material resembling laterite in appearance, but often without any hydroxide of alumina. However, there is sandy matter present and the weathered outcrop would generally be termed lateritic sandstone or some similar name, in spite of the fact that it is a local replacement and not truly laterite. It may also happen that an accumulation of detrital laterite on shales or clayey rock may produce an argillaceous material resembling laterite and yet with sufficient combined silica in it to exclude it from a strict definition of the term laterite. This material may, notwithstanding, be called a lithomargic laterite or a lateritic lithomarge.

The Formation of Lateritic Soils.—This is perhaps the most confusing subject of all. It, on the one hand, involves all soils in which real lateritic *débris* has become incorporated and forms a large part, and, on the other hand, concerns the irregular use of the words "laterite" or "lateritic" for any red soils or rusty outcrop of weathered rock. Heavy rain will tend to erode both soils and rock outcrops, so that it once more becomes evident that alternating dry and wet periods of sufficient duration will favour rock weathering and the beginning of lateritisation. But de-silicification and leaching are essential characteristics of this process. In most cases rock weathering is simply an oxidising and hydration phenomenon, whereby the silicates tend to break up and liberate the bases which thus become available to vegetation. Such newly formed soils are usually rich from the point of view of the agricultural chemist and the forest officer. They still retain most of their constituents—potash, phosphorus, etc., and in a soluble form for plants. The silica content of

such soils is usually so high that no one could regard them as in any way lateritic. In the case of those soils in which laterite has been incorporated the analysis will show the high percentage of alumina and ferric oxide (as hydrates).

Red soils found on basaltic rocks and termed *bole* by us and *rot erde* in Germany are of the type mentioned in the previous paragraph and are in no wise lateritic although this adjective is often given to them. Similarly the red clays found on limestones and intimately associated with them and termed *terra rossa* by the geologists of the Adriatic seaboard are rich in silica. They are not the direct oxidation and hydrated products of simple rock weathering as is the case with *rot erde*, but represent the insoluble residue when limestone is dissolved away in solution. They may contain appreciable amounts of metallic bases—lime, magnesia, soda and potash—but are not usually as fertile as *rot erde*, although better than laterite. These red clays are relatively impervious to percolating water, and hold and yield up appreciable amounts of water. However, the combined water in laterite is greater than that of these clays, but it is strongly held and so not available to plant life.

The remainder of the Pamphlet under consideration is of a chemical nature and should be intelligible to those interested in soils. The general statement given above should make the geological aspects of the paper clearer. I would refer the reader to two publications by myself, namely 'Bauxite and Aluminous Laterite' published by Crosby Lockwood & Son, London, 1932; and 'The Bauxite and Aluminous Occurrences of India', *Memoirs, Geological Survey of India*, XLIX, Part I (1923).

DURABLE BAMBOO LACQUER-WARE IN BURMA.

By U Pe Kin, P.F.S., Burma.

(1) The bamboo lacquer-ware with which we are familiar in Burma, is that made in Pagan and Nyaung U on the Irrawaddy river. The picturesque designs and paintings of old Burmese character are of

much interest. They are more of the nature of curios than useful articles. Lacquer-ware is not durable and cannot be used for daily domestic purposes.

(2) There is, however, one place near Monywa on the Chindwin river known as Kyaukka, where lacquer-ware durable enough to stand rough daily usage is made. It is, however, lacking in art and beauty, and this is one of the reasons why it is less popular than that made on the Irrawaddy river. Various utensils such as cups, bowls, trays, baskets, small boxes and tiffin carriers, are made in Kyaukka and are generally known as "Kyaukka-ware." Kyaukka ware used daily has been known to last from eight to ten years without receiving dents and without the paint coming off. It is doubtful if aluminium ware would be free of dents and scratches after being used a year or two in the average Burmese home. Kyaukka ware has a certain amount of elasticity and can be handled fairly roughly without breaking or being dented. Another advantage Kyaukka ware has over aluminium ware is that it can be washed and cleaned far more easily. In Monywa town, which is only about ten miles from Kyaukka, there is scarcely a house without a Kyaukka utensil of some kind or other.

(3) Kyaukka ware evidently deserves more attention than is paid to it. The industry is little known as it is confined to a single village and cannot turn out large quantities. The process of manufacture is simple and it is very probable that the industry would prosper, if made widely known.

(4) There are three steps in the manufacture of bamboo lacquer-ware. The first step consists in making the bamboo skeleton. *Tinwa* (*Cephalostachyum pergracile*) owing to its great flexibility is preferred to all other bamboos. The bamboo is cut into convenient lengths, the nodules being excluded, and is split radially into small strips called *hnis*. Radially split *hnis*, according to the manufacturers, are much stronger than the usual tangentially split *hnis*.

(5) A strip of *hni* is made into a circle with the ends tied together with a piece of thread, as shown in diagram (A). A second *hni* is inserted between the two ends "a" and "b" and its loose end fixed

The first step in the manufacture of bamboo lacquer-ware—making the bamboo skeleton.

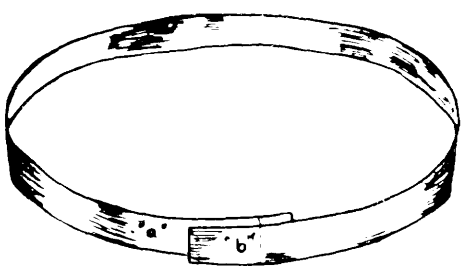


Diagram (A)

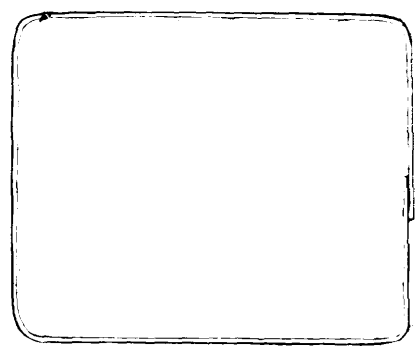


Diagram (C)

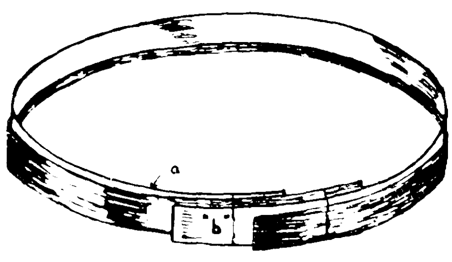


Diagram (B)

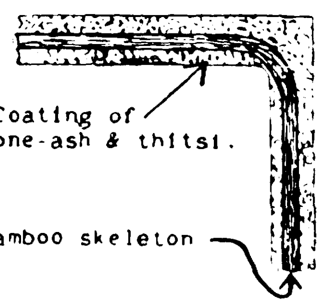


Diagram (D)

U Pe Kin.-Bamboo Lacquer-ware.

with another piece of thread, as shown in diagram (B). More *hnis* are added in a kind of spiral form until the required pattern is obtained. This is the most interesting part of the industry to watch. Strip after strip of *hni* is inserted with extraordinary skill, and in a few minutes the shape of a basket or a bowl is obtained. If the pattern is slightly wrong or out of shape, the whole structure is dismantled and started over again.

(6) The second step consists in fixing the bamboo structure with a thick coating of *thitsi* (a black oleo-resin from the *thitsi* tree, *Melanorrhœa usitata*) mixed with bone ash. This process is known in Burmese as the *thayo-kaing* process, which literally means "handling with animal bones." Bone ash is used probably owing to its absorbent quality. Bone ash and *thitsi* properly mixed form a tough concrete mass when dry. To make it smooth, after being applied to the bamboo structure, it has to be rubbed vigorously with sandstone. The lacquerers at Kyaukka pay special attention to this process; hence the durability of Kyaukka ware.

(7) Sharp bends and angles are avoided as much as possible in making the bamboo skeleton. The *hni* cannot be bent to obtain a sharp angle without breaking, and a broken *hni* reduces the strength of the article. Lacquer utensils therefore generally have easy and graceful outlines. Sometimes when it is necessary to make articles with angles, such as boxes, square trays, etc., the following method of making angular shapes without breaking the *hni* is adopted. A strip of *hni* is made into a rough square without sharp angles, as shown in diagram (C). At the four corners the *hni* is bent as much as its flexibility will permit. More *hnis* are added until the required pattern is obtained. A coating of *thayo*, *i.e.*, a mixture of *thitsi* and bone ash is then evenly applied. At the corners more *thayo* is added and shaped into an angle as shown in diagram (D).

(8) After the *thayo-kaing* process, the articles are ready for the final lacquering process. Most vessels have only an inside lining of lacquer, the outside being painted black with *thitsi* which is well rubbed in with the hands. No brush is used in applying the paint.

The articles are then placed in a dust-proof room from eight to ten days to become dry. When thoroughly dry they are taken out and are ready for sale.

(9) Kyaukka ware is practically unknown in Lower Burma, because the outturn is small and the export limited to a few towns in Upper Burma. Where it is used it has been fully appreciated.

PLANT PATHOLOGY IN THE FORESTS OF INDIA.

PART III.

By R. S. Hole.

13. *Trametes pini*.—Passing now to another class of cases primarily characterized by the damage done to the aerial stems and branches of trees by so-called Wound-Fungi, *i.e.*, fungi which gain access to the internal tissues by means of wounds, we may regard *Trametes pini* as probably the most important example at present in India from a forest point of view, on account of the extensive damage done by it to the blue pine (*Pinus excelsa*). As there was some doubt regarding the extent to which infection by this fungus might be conveyed through the roots, I made a study of this fungus in the blue pine forests of the Simla and Bashahr divisions of the Punjab in 1911, with the object of determining to what extent infection in India usually takes place through branch or stem wounds and the roots, respectively. This inquiry showed that the rotted heart-wood with the cavities and white cellulose patches so characteristic of the attacks of *Trametes pini*, the production of which causes the fungus to be so important from an economic point of view, were invariably found more or less well-developed in the immediate neighbourhood of the sporophores and that this rot decreased as one passed away from this point, upwards towards the apex of the tree, or downwards towards the base of the tree. This indicated that the growth of the fungus probably commenced in the vicinity of the sporophores, *i.e.*, that first infection probably started at these places. The sporophores also were invariably found on the sites of wounds where the interior

wood had been exposed to the air and usually near the stumps of branches. The majority of the primary sporophores, also, were found to be situated on the side of the prevailing wind. These facts indicated that in India, as in Germany, where this fungus had been very carefully studied for many years on *Pinus sylvestris*, infection is as a rule, effected by wind-carried spores and takes place through wounds which, in the locality in question, are chiefly due to lopping. These conclusions were generally accepted as correct by the local forest officers and steps were accordingly taken to prohibit the lopping of pine in the reserved forests.

14. *In the root-grafts examined, infection by T. pini not found.*—The evidence on which these conclusions were based was published with illustrations in *Indian Forest Records*, Vol. V, Part V (1914-15). In paragraph 8, page 13, of this publication, it is argued that trees which were not connected by root-fusions with other trees bearing the sporophores of *Trametes pini* could not have been infected by hyphae passing through the roots. It was here assumed that the first attacking hyphae of the fungus would only be present in the apparently sound and unaltered tissues of a tree in the near neighbourhood of wood which had been obviously attacked and rotted by the fungus, as is believed to be the general rule with wood-attacking fungi of this kind. Such observations as I was able to make also indicated that this rot only extended into the roots after it had been extensively developed in the wood of the stem, with a corresponding production of more or less numerous aerial sporophores. Hence, it was deduced that infection through a more or less completely grafted root could not occur unless one of the trees connected in this way carried the sporophores of the fungus and as a general rule this is believed to be correct. At the same time exceptional cases may no doubt occur, *e.g.*, when the first infection is near the base of the stem of a tree which happens to have a long-standing root-fusion containing heart-wood in the near neighbourhood, or in the case of a tree from which the sporophores happen to have been removed by some agency; the statement in question, regarded as a generalization true without any exception, should be qualified accordingly. In the case of the six

individual trees, however, to which this argument was actually applied in the publication quoted above, the more or less completely grafted roots of all of them were carefully examined in the neighbourhood of the junctions and in every case were found to be apparently quite sound and free from rot, while microscopical examination also showed that when heart-wood was present near the junctions it contained no hyphae. The statement in paragraph 8 of the *Forest Record* mentioned above, to the effect that, even in forests where there is a very high percentage of more or less complete root-fusions, infection is as a rule, conveyed through wounds by wind-carried spores and not by hyphae through the grafted roots, is therefore believed to be correct. Trees may of course be infected by *Trametes pini* some years before a sporophore is produced, as is clearly pointed out on pp. 18 and 21 of the publication mentioned above.

15. *Doubtful if T. pini can attack healthy actively functioning sap-wood.*—Whether this fungus can attack the healthy, actively functioning sap-wood of the blue pine is doubtful. The characteristic rot with white cellulose patches caused by it is produced, so far as my own observations go, only in the heart-wood. Not infrequently, however, especially in trees which have been severely lopped, in the neighbourhood of the sporophores the sap-wood as well as the heart-wood is more or less completely disintegrated, but in such cases the rot is, as a general rule, more advanced in the heart-wood which probably indicates that the attack started in the heart-wood. Such rot in the sap-wood, as in the case of the typical heart-wood rot, is usually worst near the sporophores and decreases as one passes away, from the sporophores up or down the stem. Mr. G. H. Alington, however, who examined a specimen of this sap-wood rot in the blue pine, found that it differed strongly from the heart-wood rot usually regarded as typical of the attacks of *T. pini*. In this case, the characteristic white cellulose patches were absent, the tracheids showed little or no sign of delignification and disintegration was apparently caused by the walls of the tracheids becoming excessively brittle and fracturing into small fragments. Even if, as at present appears possible, this second type of rot is caused by the hyphae of *T. pini*, this by no means

proves that the actively functioning sap-wood of a healthy tree is liable to infection, for the severe lopping, during the period of vegetative activity to which the blue pine is frequently exposed, almost certainly greatly diminishes the tree's normal powers of resistance and probably reduces considerably the capacity of the internal living tissue to produce a liberal supply of resin, on which the protection of the wood to a considerable extent seems to depend, this apparently being the reason why the non-resinous heart-wood is chiefly attacked by this fungus. It is desirable that further information should be obtained on this point of sap-wood attack, by artificially inoculating with pure cultures of *Trametes pini* healthy unlopped pine trees which are free from other fungal hyphae, to see whether, under these conditions, the hyphae of this fungus can successfully attack the healthy sap-wood and inner bark of this tree. Observations made by Mr. Alington indicated that in cases where the mycelium of *T. pini* is present in the wood near the cambium, *e.g.*, of a living branch of small diameter, whereas the hyphae appear able to penetrate readily inwards towards the centre of the branch on the side of the heart-wood, their passage outwards towards the living cambium was prevented by the production of layers of protective cork and by local accumulations of resin. Where this had taken place, also, the tracheids produced by the living cambium, instead of being normal, were found to be more or less twisted and distorted. A similar state of things was found where the living tissues of the inner bark and sap-wood of the stem were in close contact with the hyphae containing wood of branch-stubs and the hyphae at the base of the external sporophores. If the hyphae were able to attack and kill the living tissues of the sap-wood, cambium and inner bark also, we should expect to find the sporophores developed at any part of the attacked stems, instead of only at the sites of wounds and of dead branch-stumps, as is actually the case. These facts certainly seem to indicate that *T. pini* cannot attack the healthy living tissues of the blue pine.

16. *Infection of blue pine by T. pini through root-grafts not yet definitely proved.*—The late Mr. G. H. Alington carried out much excellent research at Dehra Dun in connection with the study of this

fungus and it is greatly to be regretted that his premature death in the Great War prevented the satisfactory completion and publication of his work. One of his most interesting results was the discovery that in practically all the specimens of blue pine examined by him, including those which had been collected by me in 1911, fungal hyphae were widely distributed in the apparently quite healthy tissues of the stem and roots (including the small roots and rootlets down to those with a diameter of only $\frac{1}{25}$th of an inch), especially in the sap-wood close to the cambium and frequently also in the living tissues of the inner bark, these hyphae being very similar in appearance to those found in wood exhibiting the rot typical of *T. pini*. These hyphae were, for instance, found in every case in the sap-wood of the more or less completely grafted roots of the six trees mentioned in paragraph 14 above. They were also found in the sections of root and stem of trees which carried no sporophores of *T. pini* and the wood of which showed no rot. When numbers of these hyphae were present in the sap-wood and inner living tissues of the bark in the immediate neighbourhood of the cambium, no reaction on the part of the living tissues of the tree resulting in a local accumulation of resin, in a production of protective cork layers or of twisted abnormal tracheids, was noticed similar to that observed in the neighbourhood of hyphae of *T. pini*, as mentioned in the last paragraph. Tissues in which these hyphae were present in considerable numbers, moreover, did not appear to differ in any noticeable respect from the normal tissues of healthy trees and no fracturing or delignification of the tracheid walls was observed similar to that usually associated with the presence of *T. pini*. Examination of an apparently quite sound piece of pine timber obtained from a forest in a locality where *T. pini* was not as yet known to occur, also, showed the presence of similar apparently harmless hyphae in the sap-wood, none being present in the heart-wood. On the other hand, these hyphae could not be found in the stem of a blue pine growing in the soil of a garden at Dehra Dun, several cylinders of the wood and bark of which were extracted for examination with a Pressler's borer. These facts appeared to indicate that the widely distributed hyphae generally found in the apparently sound and

healthy sap-wood and inner bark of the stems and roots of trees growing in forest soil in their natural habitat probably belonged to a more or less harmless, or possibly even a positively beneficial, symbiotic species, similar to that reported to occur for example in *Calluna*,* instead of to the injurious *T. pini* to which they were at first thought to belong. This is obviously a point of considerable importance which requires further investigation with the object of identifying this fungus and if possible of discovering its influence on the nutrition and healthy development of the blue pine. Meanwhile, the statements made in the *Forest Record* mentioned in paragraph 14 above and elsewhere,† based on the observation that hyphae resembling those of *T. pini* were found in the apparently sound tissues of grafted roots, to the effect that the blue pine may be infected by *T. pini* through root-fusions, must be regarded at present as not yet having been certainly proved. It may no doubt occur occasionally, *e.g.*, in old grafts in which heart-wood is well developed at the junctions. On the whole, however, in the light of the evidence at present available, it may be said that first infection of the blue pine through the roots by *T. pini* in India is probably so rare an occurrence that it may be regarded, as a general rule, of practically no importance in connection with the economic control of this injurious fungus.‡ The history of the investigation concerning this fungus in India is of particular interest, inasmuch as it indicates, first, the value of good work of every kind, and secondly, the great advantage of combining careful laboratory work with an extensive study of the conditions under which a disease is found to occur in the forest. If the laboratory work of Mr. Abdul Hafiz Khan had not first drawn attention to hyphae apparently identical with those of *T. pini* in the tissues of grafted roots which appeared to be quite sound (*Indian Forester*, XXXVI, 1910, p. 559) attention would not have been directed to the fact discovered by Mr. G. H. Alington, which may prove to be of considerable importance,

* See for instance, *Obligate symbiosis in Calluna vulgaris*, by M. C. Rayner, in *Ann. Bot.*, 29, p. 97 (1915), also *Bot. Gaz.*, 73, p. 226.

† *Indian Forest Records*, l.c. pp. 3, 15, 20 and 21, also *Indian Forester*, Vol. 36 (1910), p. 559.

‡ First infection may of course occasionally take place directly through wound in roots which are exposed above the ground surface as has already been pointed out by the writer (*Indian Forest Records*, l.c. page 16 and Plate IV, Fig. 1).

that there is a fungus which seems to be able to live in the tissues of the blue pine as a more or less harmless, or possibly even beneficial, symbiont.

17. *Resistant power of host and attacking power of fungus.*—Hitherto in this paper I have especially emphasized the importance of the general health and resistant powers of the plant to various diseases, (*Indian Forester* XLV, 1919, p. 584). This, however, must by no means be taken to imply that I have any desire to minimize unduly the importance of fungi or their power to do immense damage under particular conditions. There are always two factors which must be taken into consideration, first, the conditions increasing or diminishing the plant's powers of resistance, and secondly, the conditions increasing or diminishing the attacking powers of the fungus. An interesting case I noticed in the botanical garden at Dehra Dun, which possibly is an illustration of the first point, but which was not worked out in detail, is that the grass *Triraphis madagascariensis,* when cultivated in the moist heavy soil of the Dehra Dun garden, constantly had its ovaries attacked by a disease to such an extent that I was unable to obtain any sound seed from the plants for further sowings. Locally, this species grows on a sandy, or gravelly, well-aerated soil where this disease is not as a rule noticeable. As regards the second point, another case which I noticed incidentally at Dehra Dun may be mentioned. I had several excellent specimens of *Grewia asiatica* growing very well in the garden for some years. I then introduced near them some specimens of *Grewia lacei* grown from seed which was sent to me from Burma. The latter at first grew well and attained a height of some six to eight feet but were then suddenly attacked, during the rains, by what appeared to be a most virulent twig and branch-killing disease. The latter then appeared to pass on to the neighbouring plants of *G. asiatica* which, up to that time, had been quite healthy. This disease appeared to me to be so dangerous that I at once removed and destroyed my entire stock of *G. lacei* (although I was particularly anxious to have this species represented in our garden collection) together with all the infected branches of *G. asiatica*. This case was not investigated in detail but was possibly an instance of what Pro-

fessor Marshall Ward especially emphasized, *viz.*, the influence of the kind of nutrition in strengthening the powers of attack of injurious parasites, and an example of the important part which susceptible species in a forest crop may play in the propagation of disease.

18. *Spike disease of Zizyphus oenoplia.*—In his Croonian Lecture of 1890, Professor H. M. Ward pointed out that epidemic outbreaks of disease are liable to occur when the conditions of the environment are at once unfavourable to the health of the host plant and favourable to the vigorous development of the parasitic fungus. He also explained that wet, cloudy weather during the season of vigorous vegetative activity is liable to produce an unsatisfactory physiological condition in green plants on account of diminished transpiration, depressed assimilation and respiration with diminished aeration of the tissues, which results in the latter becoming surcharged with water containing large quantities of glucose and organic acids in solution, in the construction of thin, soft and delicate cell-walls and in the protoplasm becoming unusually weak and permeable. Professor Ward emphasized the fact that it is precisely these conditions of moisture, diminished light, a food-supply of glucose, soluble nitrogenous substances and an abundance of organic acids in solution, with a relatively permeable non-resistant protoplasm in the cells of the host-plant, the walls of which are unusually thin and weak, which are particularly favourable to the nutrition and successful attacks of fungi like *Botrytis*. He also showed that a diminished transpiration and wet cloudy weather at the end of July and beginning of August were particularly favourable to the spread of the *Phytophthora* Potato Disease. It is believed that a very similar state of affairs plays an important part in what is probably the most notorious disease in Indian forests, *viz.*, the so-called spike disease. Most forest officers in India are well acquainted with the great powers of resistance to, and recovery from, ordinary injurious influences, such as cutting and mutilation, possessed by the very strong-growing, robust, thorny shrub and climber *Zizyphus oenoplia*. Considerable areas of this species, however, during the rains, are not infrequently seen which look as if the plants had been sprayed with some virulent poison. The cause of this injury is apparently to be

found in one or more species of twig and branch-attacking fungi which, so far as I am aware, have not yet been certainly identified, but in the tissues of plants injured in this way the hyphae of fungi are constantly found. Repeated, more or less severe injury of this kind which results in the death of the twigs and lateral branches, in time appears to weaken and cripple the plants and the observations which I was able to make indicated that the curious twiggy growth commonly known as spike in this species is, sometimes at least, the secondary effect of such damage, the abnormal growth being possibly caused by a toxic substance excreted by the fungal hyphae in a diluted condition getting into the sap-circulation of plants which have been injured and weakened in this way and possibly also by other factors (*Indian Forester*, Vol. 44, 1918, pp. 330—334 with illustrations and Vol. 45, 1919, pp. 137, 138). It is now generally acknowledged that one and the same species of fungus may be sometimes a harmless saprophyte, or possibly an actually beneficial symbiont, and at other times a strong parasite, according to variations in the resistant power of the host and attacking power of the fungus and according as the environmental factors favour the healthy development of the host or parasite, respectively. Similarly it seems rational to conclude that, whereas under some conditions the toxic substances excreted by fungi may be able to kill the host cells in their immediate vicinity, these same substances may be able to do no more than modify and render more or less abnormal the growth of the host tissues, *e.g.*, when the strength of the poisonous substances has been much diminished during their dilution and transport in the transpiration current to tissues situated at a considerable distance away from the fungal hyphae or when the resistant power of the host's protoplasm has been sufficiently strong to neutralize the greater part but not all of the poisonous excretions. An interesting example of an abnormal morphological condition produced by a substance excreted by the hyphae of a fungus at a considerable distance away from the actual hyphae is apparently seen in the *Silver-Leaf Disease* of plum, apple and other trees, produced by the fungus *Stereum purpureum*, see a paper by F. T. Brooks and H. H. Storey in *Journ. of Pomology and Horticultural Science*, Vol. III, No. 3, September, 1923. See also

Kew Bulletin, 1917, p. 326, where W. B. Brierley has shown that abnormal development in host tissues may be caused by the fungus *Botrytis cinerea* at a considerable distance away from the actual hyphae). From this point of view the condition known as Spike in *Z. oenoplia*, being the secondary result of more or less severe direct damage by one or more species of fungi is seen to differ considerably from the morphologically somewhat similar "witches' broom" formation on the European silver fir (*Abies pectinata*) produced by the fungus *Aecidium elatinum* which is usually a strictly localized and comparatively harmless development in small portions of an otherwise healthy tree and where we have, as Professor Ward points out, a condition which closely approaches to that of symbiosis or mutually beneficial commensalism.

19. *Spike disease of Santalum album.*—When I first became acquainted with the spike disease of the sandal tree (*Santalum album*), I was primarily impressed by the fact that it was almost invariably associated with various obviously injurious factors and conditions which appeared to be more or less definitely unfavourable for healthy development. It seemed to me, then, that the prolonged action of these injurious conditions by causing a slowly but steadily increasing accumulation of carbohydrates in the leaves might in time lead to a permanent physiological derangement and thus produce the disease through abnormal and unregulated enzymatic action. (See *Indian Forester*, Vol. 43 (1917), pp. 429–442 and *Journ. As. Soc. Beng.* (New Series), Vol. XIV (1918), No. 6, pp. clxiii–clxv). In the short time at my disposal for this work in India, I was unable to obtain experimental proof of the theory of unbalanced sap-circulation. In view of the facts which subsequently came to light in connection with the similar disease in *Z. oenoplia*, however, it seems possible that the explanation of the disease of *Z. oenoplia*, suggested in the last paragraph, may also be found to apply in the case of the sandal, (see *Indian Forester*, Vol. 44 (1918), pp. 330–334 and Vol. 45 (1919) pp. 137, 138), *i.e.*, that the disease is primarily due to a toxic substance, or substances, excreted by one or more species of twig-attacking fungi, the attacks of which are probably favoured by periods of dull, cloudy, wet weather in the season of vigorous vegetative activity and possibly also by

various other injurious factors. If this is eventually proved to be the case, it may ultimately be possible to exercise some effective control over the disease, by removing dead branches, twigs and susceptible species, which harbour the attacking fungus or fungi, by encouraging in the sandal areas the growth of species not usually attacked by them, by the establishment of protective belts of such species, by avoiding all unnecessary injuries to the trees and by promoting, so far as possible, their vigorous healthy growth.

20. Enough has now, I think, been said to show that considerable progress has been made, since the establishment of the Forest Research Institute at Dehra Dun, as regards our knowledge of some of the most important plant diseases in Indian forests, and that a rich and promising field of study in this direction awaits research, in which extensive work and careful observation in the forest are combined with intensive work in the laboratory, and experimental garden, in which close co-operation is secured between practical forestry on the one hand and the study of mycology and ecology, on the other hand. In connection with the work which was done on these lines while I was Forest Botanist at Dehra Dun, I wish now particularly to acknowledge the valuable assistance given to me by the late Mr. G. H. Alington who did excellent work in the investigation of *Trametes pini*, by Mr. Abdul Hafiz Khan, my Assistant at Dehra Dun from 1915 to 1923 and by Dr. F. Shaw of Pusa who gave us much help in connection with *Polyporus shoreae*. Some years ago, I suggested to Mr. Hafiz Khan that he should prepare a paper, more or less supplementary to that published by Mr. Gamble in *Indian Forester*, Vol. 25 (1899), p. 431, detailing, chiefly from the systematic point of view, the progress made since 1899 in the study of forest fungi in India, and the present paper will, it is hoped, to some extent serve as an introduction to that paper, especially as regards explaining what might perhaps otherwise be regarded as the unaccountably meagre additions which have been made to our knowledge of Indian forest fungi, from a purely systematic point of view, since the publication of Mr. Gamble's paper.

During the time that I held the post of Forest Botanist, no collections on a large scale were attempted and the new species which were

added to our list of forest fungi were :—

(1) those which are more or less directly connected with serious diseases of real importance in economic forestry ;

(2) those which, although themselves more or less completely innocuous, resemble, or are often associated with, and therefore may be confused with fungi of class (1) occurring in the same localities and ;

(3) those which, being of no immediate forest importance, happen to have attracted the attention of forest officers and others and being found on forest species were sent to Dehra Dun for identification.

A CHALLENGE TO STEEL AND CONCRETE.

By S. Kamesam, B.E., M.E., A.M.I.E., Officer in Charge,

Wood Preservation Section, F. R. I.

The two principal conditions that a structural material has generally to satisfy are strength and resistance to factors tending to disintegrate it. As regards the former, it is, obviously, neither the strength per unit volume, nor that per unit weight that is important, but that per unit of money. The life of a structure may not necessarily be determined by the chemical permanence of the material which may become quite secondary if either the obsolescence factor in reckoning and limiting the life of a structure, or the mechanical life of the structure is less than its durability life. In these years of rapid engineering progress, and constant change in human outlook as regards comfort, aesthetics, etc., the theory of "direct benefits" has definitely superseded the "ability to pay" theory as a basis of assessing the ultimate utility and economy of structures.

Had it not been for the fact that steel has been sold on the basis of weight, and timber on the basis of volume, the merits of timber would have been, perhaps, more speedily recognised. Weight for weight, timber, almost irrespective of the species, is as strong as steel,

and about seven times as strong as cement concrete. Weight for weight, timber, especially in the round, is much cheaper than steel. In the case of concrete, compared to steel and wood, are we not loading structures with great loads of sand and stone which contribute more weight than strength? The safe strength in compression of concrete is about a half to a third of that of wood; in tension the strength of concrete is, for all practical purposes, negligible; volume for volume it weighs two and a half to four times as much as wood. The average layman is of the opinion that timber is too weak for building most modern structures. A properly designed timber structure is as strong as that of steel or of concrete. When it is realised, however, that in the United States of America there are several thousands of railway timber bridges (built not of strong hardwoods, but of relatively weak coniferous timbers) over which some of the heaviest locomotives and trains thunder past, it will be seen that timber is as suitable as steel for even some of the most exacting structural purposes of to-day. India has been specially fortunate in having very strong structural timbers like *sal* (*Shorea robusta*), *asna* (*Terminalia tomentosa*), *baliga* (*Poeciloneuron indicum*) etc. which are 50 per cent. to 150 per cent. stronger than the standard structural woods of Europe and America. Being a tropical country, timber grows rapidly in India. It is a crop and not a mine. Hence, it is inexhaustible if only the annual growth is utilised. If properly treated and fabricated there are but few structures for which it cannot be used, consistent with a maximum of initial and final economy.

In these days of extensive research, the economic or mechanical permanence of most structures cannot be reckoned to be much over 25 to 30 years, a period which, usually, synchronises with the average life of properly treated timber. Even assuming that the life of a steel or concrete structure,—the minimum as limited by mechanical, obsolescence, or chemical factors,—is as high as 60 years, and if the average life of a corresponding structure of treated wood is assumed to be only 25 years, a simple arithmetical calculation will show that, *for equal ultimate economy* (neglecting several minor factors) *the steel or concrete structure should not initially cost more than about one and a*

third times the cost of wood. Based on this criterion, an engineer can easily see, by estimating, that only in very few cases steel or concrete can compete with treated wood.

The improvement of the mechanical technique of impregnating wood with antiseptic fluids, the availability of a cheap but effective wood preservative, and the evolution of very efficient connectors for making timber joints are three potent factors that can, by their application, shake the proud position at present occupied by steel and concrete in structural engineering. As far as India is concerned, it is no exaggeration to say that few of her engineers are aware of the potentialities of the three above milestones in the utilisation of timber. Practically, all the timber resources as well as the public utilities of this country are owned by the Government of India, therefore intensive propaganda, based on sound scientific data, on the part of the Forest Department is imperative for inducing and encouraging engineers of government departments like the Railway Department, the Post and Telegraph Department, and the Public Works Department to use treated Indian timbers in place of steel and concrete for various kinds of structures like railway and highway bridges, electrical poles, cross-arms, etc. A start has been made by the writer in this direction. If the Forest Department is anxious to augment the income of Indian forests, it is very necessary and urgent to find out new avenues for the use of treated timber, especially of species and of sizes which cannot, at present, be exploited for railway sleepers, and are either used for converting into cheap building timber or into fuel. They must also be ready to supply the necessary data and guidance for facilitating engineer users to draw up specifications for the purchase of the proper kind of timber, and for antiseptically preserving it. Again, supposing that a demand for timber is created, the question arises whether the Forest Department is ready with accurate facts and figures of the approximate cost and availability of different structural timbers especially in the round, in various parts of India. The case for timber as a structural material has, to a certain extent, already suffered by default. It is, naturally, for the supplier to place at the disposal of the customer—who has got comfortably used to and is satisfied with

steel and concrete—the requisite technical knowledge and statistical data that are essential before engineers can adopt treated timber as a standard structural material. It is the writer's conviction that India will see, in the near future, a better and more general appreciation on the part of her engineers of the economy and manifold advantages of timber as a structural material. Consequent on this, a more extensive utilisation of Indian timbers is inevitable. Signs are already looming on the horizon in this direction as a result of propaganda which is hardly a year old. Only, let the Forest Department be prepared when engineers, convinced of the technical aspects of the question regarding the superiority of wood as a structural material, wish to know the sizes and quantities of timbers, and particularly of round timber and poles, available in different parts of the country.

IMPROVING BULLOCK-CART WHEELS.

By S. B. Naidu, B.E., A.M.I.E., Wood Technologist at the Government Central Wood Working Institute, Bareilly.

With a view to protect road surfaces from undue wear and tear caused by the cutting and crushing action of the narrow iron tyres of cart wheels, certain restrictions should be imposed in the future, limiting the minimum width of the iron tyres of wheels permitted on public roads. If this suggestion is adopted, as it may be, such existing tyres as are considered too narrow in the interest of the roads may have to be replaced by wider tyres. During the removal of the old narrow tyres, the general condition of the various parts of the wheel may be such as to necessitate scrapping the wheel completely. This should give an excellent opportunity for the village wheel-wright to consider the possibilities of making an improved type of wheel.

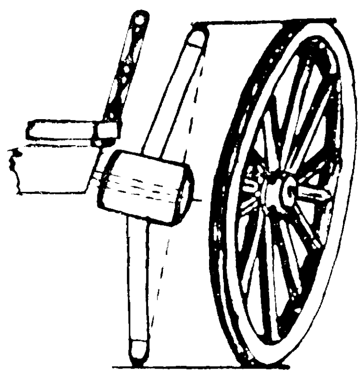
Massive wheels.—Many of the cart wheels are built badly and too massively for the loads they ordinarily carry and for the road surface for which they are intended. Ordinarily the felloes need not exceed 4 inches in thickness if the wheels are properly constructed, except in the case of village cart wheels which are made without tyr es and meant

for work in fields or soft ground. Even in the case of an average gun-carriage meant for heavy duty it has not been found necessary to make felloes more than 3 inches square in section and spokes $3\frac{1}{2}$ inches square at nave and 3 inches square at felloe end. The wheels in this instance are generally made of teak. In the case of country cart wheels in the United Provinces felloes and naves are generally made of *shisham* and spokes of *sal* wood, but *babul, dhauri* and various other timbers are also made use of depending upon the availability and cheapness of the timber in the locality. Experience has taught the average country wheel-wright to make use of the strongest and stiffest timbers out of those available in the district, and invariably it will be found that such timbers are never less than 80 per cent. in strength, tension, compression or stiffness compared with teak; but the same experience has not taught him to reduce the dimensions of the wheel for lightening the load on the draft animal. Owing to ignorance of the correct principle of construction of the wheel, he probably finds the present factor of safety necessary for the life of the wheel. In an average country cart-wheel the axes of the felloes, the spokes and the mid-section of the nave through the circumference all lie in one plane and this plane is in a vertical position when the cart moves. This is neither the correct method of construction nor the right way of fitting the wheels to the arms of the axle bed.

Forces on wheels.—The wheels during action not only have to stand the downward weight of the load but also a horizontal thrust against them at the centre, sometimes to the right and sometimes to the left. Proof of inferior design, construction and usage are the horrid shrieks and the nerve racking screams of agony raised by the arms of the axle bed in the box, complaining against the negligence of the cart-man in greasing the wheels. The ordinary traveller must be familiar with these noises which are due to the battering action of the arms of the axle bed against the inner face of the nave. The battering action is greatest when the cart is fully loaded. Owing to the load on the cart swinging to the animals' strides a sharp and vigorous horizontal thrust to the off side wheel is given when the load tends to swing to the near side and so on. This goes on with an average loaded bullock

cart all day long. Wheels with the axis of the spokes and the felloe in one plane generally fail due to the crushing of the tenons of the spokes at the nave.

'*Dish*' *in wheels*.—To counteract this horizontal thrust, wheels should be constructed with a slight 'dish'—, that is, they should be built to resemble flat saucers with the concave side outwards. The slight inclination of the spokes owing to 'dishing' sets up a horizontal reactionary force to counteract the effect of the battering action to a considerable extent. Making the wheel with a "dish" necessitates the arms being fixed into the axle bed slightly to an angle. The inclination of the arm assists in bringing the spoke that is directly under the load into a vertical position. During movement each spoke in its turn assumes this position—the position when the spoke will be called upon to take the maximum load. The effect of this is to throw the upper rim further out and an end view of the tyres of the wheels would appear as though tending to converge to a point below the ground. This is the ideal condition when the rolling efficiency of the wheel is the very best.



WHEEL SHOWING "DISH"

'*Foreway*.'—The tendency of the wheel to slip off the arm is counteracted by giving a foreway to the arms, that is bending the axle slightly in the direction of the animal to a small angle, say about two degrees. This produces a tendency in the wheels to draw themselves inwards at every turn, while the lynch pin prevents the wheel from coming off the axle. Greater foreway than this should not be encouraged on account of the danger of the arm box in the wheel rubbing against the shoulders of the axle bed and creating friction. The exact amount of 'dish' and the downward bend of the arm of the axle bed is a matter of experience. Ordinarily spokes inclined 1 : 15 to 1 : 20

are considered suitable and the downward bend of the arm will depend upon the inclination of the spokes, and this is generally not more than 5°. Another advantage of 'dishing' is that it gives greater clearance between the wheels and the sides of the cart.

The battering action on the wheels due to the swaying of the cart is highly detrimental to the road surfaces. The wearing out of the roads crosswise into waves and shallow hollows which are very clearly seen by the motorist by night light are due to the momentary abrasion caused by the wheels during the ramming action.

OBSERVATIONS ON SOIL AERATION.

BY R. C. DUTTA, P.F.S., CACHAR, ASSAM.

Observations and assumptions.—(1) As the dry soil absorbs rain water it expands to a certain extent, while on sunny days with desiccation shrinkage proceeds.

(2) Shrinkage is dependent on soil temperature, the amount of moisture present, the texture of the soil and other minor factors. Taking the other variable factors as constant, shrinkage is apparently, within certain limits, a function of soil temperature.

(3) Exposed soil absorbs more solar energy than covered soil. Consequently cracks in the exposed soil are more prominent and more frequent than those in the forest. As per (2) cracks in the soil are wedge-shaped, *i.e.*, narrower at the bottom where they receive the least solar energy and wider at the top. There is a certain amount of elasticity in the soil, and in well covered forest soil slight tension caused by shrinkage is counterbalanced by such elasticity. Consequently there are fewer and smaller cracks in soil covered with forests.

(4) With the first rains a part of the water runs off and a part sinks. The part that runs away is muddy and in its journey downwards carries a load of surface soil and *dumps this into the cracks before the soil can have time to absorb and expand sufficiently*. Consequently there is a gradual lowering of soil height, a wedging in of newly deposited silt and consequently some interference with normal expansion

after absorption of moisture. The "expansion joints" gradually disappear with years of exposure, and shrinkage without subsequent means of expansion results in permanent reduction of porosity. In other words aeration is adversely and permanently affected.

Conclusions—

(*a*) Exposed soil unless broken up subsequently will deteriorate permanently.

(*b*) The wider the cracks during a hot dry season the worse is the deterioration.

(*c*) Exposure on steep soil is worse than exposure on flat country, surface drainage being quicker on hills than on plains.

(*d*) This reduction of porosity with exposure possibly explains why it is difficult to tackle a failed plantation and why so often height growth falls off towards the edge of an even-aged plantation.

Questions—

(1) whether such deterioration after a clear felling and burning is counterbalanced by subsequent activities of forest flora and fauna ;

(2) whether rotting roots of felled and dead plants improve porosity ;

(3) when the heat is intense as in a forest fire, whether interlocking of particles due to shrinkage is permanent, *i.e.*, whether they can become detached again after absorbing moisture at a later stage.

SOIL DETERIORATION IN PURE TEAK PLANTATIONS.

By H. E. Castens, I.F.S.

Forest Bulletin No. 78 of 1932 has adduced very little evidence on this subject. There have been difficulties in regenerating some old Nilambur plantations, which the methods of analysis employed could not show to be correlated with any of the chemical or physical

soil properties measured; and which there is reason to believe can be overcome by working the surface soil before planting. Java has no evidence on the subject though one writer believes some poorer soils to have shown marked signs of deterioration.

Such lack of evidence is not surprising. There are very few forests where a second rotation of teak is being planted, and still fewer (one would suspect even none) where the growth statistics for the second rotation can be compared with the growth statistics of the corresponding period of growth in the first rotation. Even were there a few such plots in existence conclusions drawn would of necessity be purely tentative; a large number of such plots on similar soils and in similar climates would be necessary to obtain a statistically sound answer to the question of soil deterioration.

From the purely theoretical stand point of the existing knowledge of tropical pedology, it is equally impossible to decide whether or not soils under pure teak plantations will deteriorate. That they will change from their original state in a way that they would not have changed had they remained under their natural forest crop may be held to be reasonably certain; such changes have been established in every case where the effect of the introduction of an artificial crop on the soil has been critically examined. But as to the direction in which this change will proceed, rate at which it will proceed, whether it will be beneficial to, detrimental to, or will have no effect on the growth of teak it is entirely impossible to foretell.

Thus, while it is true that soil deterioration has not been proved, it is equally true that it has not been disproved. Such deterioration appears likely, if it exists, to be a slow process, very difficult to detect from measurement in the growth rate of the crop; as it is impossible to compare plantation teak in this respect with natural teak, while comparative measurements of growth rate in plantations of the same age merely indicate the current soil quality—a quality which may be steadily falling off at approximately the same rate in all soils of similar initial qualities.

It is no more justifiable to remain in ignorance of this important factor in the management of plantations than it is to manage a valuable

forest without a soundly established estimate of the growing stock and without a working plan. It is true that the results of soil deterioration (if it exists) are not sufficiently striking to allow a demonstration of its effect from measurements on the tree crop within the first rotation, but this fact does not detract from the ultimate disastrous effect which a progressive deterioration of the most valuable forests (those now being planted) would ultimately have on the prosperity of the country.

Such deterioration once having taken place, it may be singularly difficult or impossible to rejuvenate the soils and bring them back to a satisfactory state of fertility. For this reason it is not justifiable to let matters slide for the present, and place the burden of the effects of our ignorance on the shoulders of the future generation. The science and practice of forestry exists as much for the next generation and the next century as it does for the present, and to fail to take reasonable precautions to safeguard the future is in a forester a moral crime as great as that of negligently allowing the burning of large areas of valuable standing timber.

It is not suggested that the proof or disproof of soil deterioration, and the devising and proof of remedial measures, will be an easy or rapidly accomplished task. It is necessary to attack the problem from three points of view. Firstly the fundamental nature of teak soils must be determined, the relative importance of the numerous weathering forces be assessed, and the direction in which normal weathering is proceeding must be determined. It will next be necessary to obtain a sound knowledge of the particular soil factors which determine the quality of a teak soil. These factors may not, indeed probably will not, be the same for all soil types or for the whole of the extended range of climatic conditions under which teak grows. Large numbers of soil samples from each predominating soil class and climate will have to be analysed in order to obtain a statistically sound estimate of the factors involved. Finally it will be necessary to analyse a large number of duplicate samples from inside and outside plantations of various ages and in various typical localities in order to obtain, by statistical comparison of the differences, a knowledge of the changes

being induced by the pure teak plantations. The direction in which pure teak plantations tend to alter the soil in each soil and climatic group will have to be compared with the soil factors proved to influence teak growth beneficially or otherwise within the same soil and climatic group, and from this comparison it should be possible to form a sound opinion as to the effects of a pure teak plantation on the soil. On the basis of the knowledge acquired in the first place into the fundamental constitution of the teak soils and of the weathering processes proceeding in them, it will be possible to suggest reasons for the changes induced by pure teak plantations, and to suggest remedial measures if necessary. These will of course, have to be proved by further research.

It is difficult to see how any sound opinion on this subject can be formed before the research outlined above has been carried out. At present there are no data on which to base a statistically sound verdict, and any statement that soil deterioration does or does not exist, or that any suggested silvicultural method will or will not improve the soil, must remain very largely a statement of opinion rather than one of fact. The statement that it is wisest to reproduce as far as possible the conditions of natural forests in teak plantations is itself such a statement ; although this object if successfully attained, should ensure that teak plantation soils do not alter in the composition relative to the natural soils in the surrounding forests. Without further knowledge of soils this course is probably as near to the ideal of conserving and improving soil fertility as it is possible to get.

THE SAFEGUARDING FORMULA FOR SELECTION FELLINGS.

BY E. A. SMYTHIES, I.F.S.

In my article on the calculation of yield in *sal* forests, published in the July number of *The Indian Forester*, I gave a formula that would tend to ensure that the yield of selection trees would not decrease from one felling cycle to the next. It was impossible in that article to discuss fully the application of this formula or to explain the exact

results of its application to practical forest conditions. Moreover, owing to a confusion in the symbols x and X, the formula as printed on pages 423 and 424 became ambiguous. I take this opportunity therefore to correct the printing mistake and to make the formula and its application more intelligible. To prevent any future confusion in symbols, it also seems advisable to alter them.

2. I start with three basic assumptions :—

A. That the formula will be applied to the usual Indian conditions, *i.e.*, that exploitable trees are already standing and being recruited anywhere (and not in particular compartments), and that the fellings pass regularly through the forest in consecutive annual coupes in a felling cycle of 10, 15, 20, or 30 years.

B. That the basic object of management is to ensure as far as possible a sustained or increasing yield of exploitable trees above the exploitable limit at every cycle.

C. That the middle-aged and younger diameter classes are well represented, and that the present rate of recruitment into the two highest diameter classes will not decrease for many decades.

These are the conditions and objects of management that apply to most of our important *sal* forests managed under " selection fellings" or as Troup calls them " exploitation fellings."

3. I will for simplicity adopt the nomenclature of the plans of 40 years ago, and refer to exploitable trees above the exploitable limit as I class, and trees in the next lower diameter class as II class. (Under assumption C above, trees of the III, IV and V classes are ignored in this article). I will also for the present ignore adjustments rendered necessary or advisable by silviculture, management, or abnormalities, and deal with these later.

4. The Working Plan Officer enumerates the forest and ascertains the present stock of I and II class trees per acre, which are indicated by the symbols I and II respectively in the formulæ given below (To justify assumption C he also enumerates the III and perhaps IV

classes, but these do not come into the calculations in any way). Calculations are then made with all available data to ascertain how many II class trees per acre pass up into the I class within the felling cycle. This number (x) is obtained from the formula.

$$x = \frac{f}{t}(\text{II} - z\% \text{ of II}).$$

where f = felling cycle.

t = time taken for II class to pass up into I class.

z = percentage of II class that die or do not pass up in t years.

Having calculated x, the Working Plan Officer has two alternative methods of prescribing the annual yield of I class trees.

(*a*) He may fix a *volume* yield of x trees per acre of coupe per annum, *i.e.*,

$$x\left(\frac{\text{total area of felling series}}{\text{felling cycle}}\right)$$

and if his data are correct, this will ensure no reduction of I class trees at the end of the felling cycle. This alternative has all the disadvantages of a *volume* yield (*e.g.*, cumulative error from inaccurate data).

(*b*) The second alternative is to prescribe an area yield, by dividing the forest into f annual area coupes, and limiting the removal of I class trees to a percentage (p) of their number per acre ($=N$) in the coupe of the year *at the time of marking*. Thus :—

the percentage of I class trees to be removed $= p$ % of $N = (\frac{x}{N} \cdot 100)$ % of N.

N is readily ascertained by the marking officer at the time of marking the year's coupe at practically no additional trouble or expense. N can be expressed mathematically in terms of I and x (assuming even distribution of I and II class trees) as follows :—

In the nth year's coupe

$$N = \text{I} + \frac{n\,x}{f}$$

while the *average* value of N during the felling cycle $= \text{I} + \frac{x}{2}$.

In calculating the value of p, we can substitute this average value of N without introducing any serious error, and the percentage of I class trees to be removed in any year's coupe becomes

$$p\,\%\text{ of }N = \left(\frac{x}{\mathrm{I} + \frac{x}{2}} \cdot 100\right)\%\text{ of }N.$$

The substitution of $\frac{x}{2}$ for $\frac{nx}{f}$ in the formula requires a little further explanation.

Theoretically if the Working Plan Officer could divide his forest into f annual area coupes, each initially containing the same number of both I and II class trees per acre (a practical impossibility in our irregular forests), then the expression

$$\left(\frac{x}{\mathrm{I} + \frac{nx}{f}} \cdot 100\right)\%\text{ of }N.$$

would give a constant annual yield of I class trees ($=x$ per acre of coupe), but would involve a quite impracticable working plan prescription, *i.e.*, a varying % of N altering for every year of the felling cycle, and this difficulty is unavoidable with the above formula. On the other hand, with the same area coupes as above, the expression

$$\left(\frac{x}{\mathrm{I} + \frac{x}{2}} \cdot 100\right)\%\text{ of }N.$$

gives a constant percentage for the felling cycle (which in practice is considered essential), but a constantly varying annual yield of I class trees, commencing with less than x per acre in the earlier coupes and ending with more than x per acre in the later coupes, but *averaging* x per acre of coupe for the whole felling cycle. But the difficulty of a varying annual yield can (in theory) be overcome by the Working Plan Officer making the area coupes initially *unequal*, thereby tending to make the number of I class trees in each year's coupe constant during the felling cycle. However the formula operates in such a way that it tends to equalise the yield in later felling cycles from fixed annual coupes of equal area (which in the 1st cycle will give unequal yields), so that this initial inequality is only a transitory feature.

Thus while the difficulty inherent in the use of $\frac{nx}{f}$ is unavoidable, that inherent in the use of $\frac{x}{2}$ is largely avoidable and hence the latter is preferable, and is therefore adopted.

This alternative has all the advantages and administrative convenience of an area yield, and in practice appears as easy to work as it is to prescribe, and mainly for this reason it is proposed to adopt it in the U. P. *sal* working plans.

This alternative may be briefly defined as follows :—

> The annual yield of I class trees is based primarily on the proportion between the present number of I class trees (I) and the number that will become I class (x) during the felling cycle, and it is prescribed as a percentage (p) of the number of I class trees (N) existing in the year's area coupe at the time of marking.

5. No formula calculation can by itself be adopted without considering the influence of various other factors, and in practical application an arbitrary allowance or adjustment (A) has to be made to cover *all other factors* influencing or liable to influence the yield. Examples of such possible factors may be quoted.

(*i*) The number of II class trees is relatively small, and the number of I class trees large, and these trees are deteriorating. In such a case A is given a plus value, and the calculated % is increased, to prevent further deterioration as far as possible.

(*ii*) The calculated % will obviously not be silviculturally available.

(*iii*) The proportion or density of I class trees is too low and the number must be increased at each felling cycle.

(*iv*) Enumerations show that assumption C is not justified and a drop in recruitment is certain in the near future. We have therefore to conserve our resources to meet this contingency.

In such cases, A is given a negative value, and the calculated % is decreased.

The formula, as applied in practice, thus becomes

$$\text{Annual yield} = \left(\frac{x}{1 + \frac{x}{2}} \cdot 100 \pm \text{A}\right) \% \text{ of } N.$$

6. Apart from its use in a so-called Selection working circle this formula can also be used to control the removal of exploitable trees in the later or unallotted P. Bs. of a conversion-to-uniform system, but here it has to be used with caution. To illustrate from the recently revised Ramnagar working plan. The *Bhabar sal* working circle with a rotation of 120 years, is divided into 8 P. Bs. P. B. I is allotted for regeneration in the 15 year working plan period. P. B. II is allotted for hoarding up the growing stock, to give as large a yield as possible when it comes into P. B. I at next revision. P. Bs. VII and VIII contain young crops regenerated under previous plans, with no exploitable trees coming on. P. Bs. III—VI are unallotted, and divided into 15 annual area coupes for controlled selection fellings and thinnings. Here $p=40$ %. At next revision, 25 % of the area will pass into P. B. II and the area available for these selection fellings will be reduced by that amount. Admittedly these selection fellings in intermediate P. Bs. are a gradually wasting asset, but we wish to keep up their yield as far as possible, and to counteract their reduced area, we must aim at increasing the number of exploitable trees per acre. This is achieved by giving A a minus value—in this concrete case A = —15 has been adopted—so that the selection yield from P. Bs. III—VI becomes (40—15) % of N, or 1 exploitable tree in 4 in the year's coupe.

7. The examples given above will suffice to show how the formula is applied in practice both in selection working circles and in conversion-to-uniform working circles, and experience to date leads one to hope that it is going to prove a useful formula. I think it is reasonable to claim that it is an advance on working plan calculations of 40 years ago ; basing the yield on the number of I class trees found in each coupe *at the time of marking* is admittedly a new idea but one of its better features; whether it is too conservative or the reverse depends on the way it is applied, and on the valuation put on $\pm$ A.

REVIEWS.

ROOT STUDIES IN THE TROPICS. IV.—ROOT COMPETITION.

BY DR. IR. CL. COSTER.

In the June 1933 number of *Tectona*, Dr. Coster has made a further valuable contribution to our knowledge of the ecology of teak plantations with particular reference to the use of mixtures, underplanting and cover crops. The investigations were made partly in the mixed plantations of Margasari, etc., raised to study the direct effects of intermixtures and underplanting (of which an account has already appeared

in *Indian Forest Bulletin* 78), and partly in pure plantations to determine whether the familiar inferior development at the edge of a plantation adjoining an older crop is to be ascribed to root competition or to other factors. Dr. Coster's summary of his paper presents his results in clear and concise form, including everything of special interest to India and Burma, so that it seems best to reproduce the appended free translation. Reference is however required to two most interesting diagrams shewing the distribution of the feeding roots of teak, *Schleichera* and *Actinophora* grown in mixture, and those of teak lines with *Leucaena* lines between them, and to the photographs which demonstrate how clear cut are the results of opening up trenches isolating a new plantation from an adjoining old one. A noteworthy feature revealed by these diagrams is the reason why of all the mixtures tried with teak, only *Leucaena* appears to promote its growth— incidentally *Tephrosia candida* in this respect takes second place among the cover crops. The diagrams and photos are not reproduced here.

TRANSLATION OF SUMMARY.

1. *Existing knowledge on the subject.*

Root competition was first taken up for experimental investigation in 1904 (Fricke). Investigations made especially in Europe and North America still further established the fact that the growth of regeneration under a shelterwood was unfavourably influenced not only by shade but particularly by root competition. Even now one cannot say just what part is played by each of the several factors which are concerned in root competition. It is known that the roots take up a great deal of water from the soil so that the competition for water, particularly in soils deficient in it, may become an extremely important factor in the struggle for existence. Mineral foods are also competed for in connection with water absorption and selective absorption, particularly in poor soils. In the tropics, the fight for soil oxygen probably plays an important part with plants of high oxygen requirement, and the great moistness during the growth period may result in an oxygen deficiency. Finally the excretion of toxic substances (other than CO^2) by the roots may possibly react unfavourably on other competing roots, but judging from what has been published on the subject, it does not appear likely that this actually happens.

2. *Investigations in teak forest.*

A. Marginal effects.—When a teak plantation is made adjoining an older crop, there is always a marginal strip 10—20 yards broad which remains behind in development, in fact many of the plants at the edge usually die off. It used to be thought that this was to be ascribed to side shade as teak was believed to be very sensitive in this respect. Extended experiments proved however that the main cause is the root competition of the older crop.

For the investigation, numerous experimental plots were laid out on 3 markedly different soil types occurring in the teak area, *viz.*, limestone, marl and loamy sand. Along the edge of the old crop ditches were dug 25 yards long and 2½ feet deep cutting through all the surface roots of the old trees which do not usually go deeper than about 1½′. Strips without a ditch alternated with the trenched strips. After one and two years the heights of all plants of the young plantation were recorded and this was done for a total of more than 20,000 plants in 53 trenched and 48 untrenched plots. The results were entirely consistent :—in the trenched plots the plants grew well almost up to the edge of the old crop, with a marginal strip only about 4 yards wide where the height was about ⅓rd less owing to side shade. In the untrenched plots many plants died in the corresponding edge strip and general development was backward. The contrast between adjoining trenched and untrenched plots was very marked (photos). The growth of the agricultural crops raised between the teak rows was similarly affected.

To meet the objection that the favourable effect of trenching might be due not to the removal of root competition but to better drainage and aeration due to the trenches, some of the trenches were refilled after removal of the cut roots. The result remained the same except that in the 4-yards edge strip, development was a little inferior to that near the open trenches, as the cut roots formed new ones which grew through the filled in trenches to a length of 3 or 4 yards (striking photo).

On 12 untrenched plots, manuring was done at a rate of 100 kg, Am. Sulph., 100 kg. Pot. Chloride and 100 kg. superphosphate per

hectare. The effect of root competition was found to be counteracted by the manures only to a small degree. (The deduction is that competition for food materials is not important.)

Further experiments were made in young crops 2 to 16 years old, all of about the same quality and bordering an old crop. Height and diameter of all trees, some 4,400, were measured in the marginal strip 20 yards wide. The data shewed that the marginal effect of the old crop on the young carries on for a number of years, reducing both height and diameter increment, particularly the latter.

Other species such as *Actinophora fragrans*, *Schleichera oleosa* (*trijuga*), *Homalium tomentosum* and *Lagerstroemia speciosa* are much more sensitive to these marginal influences than is teak.

B. Mixed crops and underplanting.—The marked sensitivity of teak to root competition having been established, it is evident that the growth of a teak crop must be greatly influenced by intermixed species or by subsequent underplanting, much more so than would be the case in Europe since all phenomena tend to extremes more quickly in the tropics than in the temperate zone.

Further results from sample plots of teak mixed with various other species are summarised (Table III) and demonstrate indisputably that the big majority of species react unfavourably on the height and diameter increment of teak, particularly on the diameter. A few species make no difference and only *Leucaena* has so far shewn any favourable effect. Only root competition which is highly specific and varied in its reactions, could account for these results.

The properties of the roots (absorptive power, oxygen requirement, etc.) and the root system (branching and penetration) determine the intensity of the root competition. For teak with its primarily surface root system, shallow rooted species are more harmful than deep rooted ones; bamboos provide an extreme case of this. The root distribution of a few *Leguminosae* are tabulated (IX) and *Leucaena* appears as the species with relatively most roots in the deeper soil layers and least in the top, *i.e.*, it has the most favourable distribution with regard to teak (*Leucaena* has 20 per cent. of its roots below 200 cms. as compared with 12 per cent. for *Albizzia falcata* and 6 per cent. for *Tephrosia*

candida, the next best two of the nine species studied). Figures (6—10) are given shewing the development of shallow roots (to 1 foot) in a mixture of teak with *Actinophora* and *Schleichera*, and in an adjoining 10-years-old plot of teak with *Leucaena* interplanted. The *Actinophora* forms a thick root net in the top soil layer 0—4" and the teak roots spread below it; being much less freely branched (this applies to both thick and thin roots) than in the *Leucaena* plot. These results were confirmed by digging up the roots in two other plots. There is thus a direct morphological influence of root competition on the teak root system.

3. *Practical conclusions.*

Isolating trenches can be used with good results wherever a sensitive young plantation requires protection against the neighbouring vegetation. In filling blanks in older crops, similar ditches may often be necessary but one must bear in mind the possible effects of the ditches on the crop (wind danger, effect of cutting the roots).

Planting space and thinnings.—Close spacing is essential for teak in its youth to prevent deleterious weed growth and to get clean stems. Early and frequent thinning is likewise necessary. Natural thinning is disadvantageous from the economic view point. In properly managed forest the trees should not stand denser in the dominating and lower storeys than is absolutely necessary to maintain the quality of the soil and in this the minimum number of stems required to give the full increment must obviously not be overstepped.

Mixtures, Underplanting, Interplanting.—In properly managed forests, the sustained yield serves as a measure of the suitability of any procedure. As on the one hand teak is extremely sensitive to root competition and on the other, its timber value far exceeds that of almost all other species, mixtures and underplanting are in the big majority of cases emphatically undesirable. Only deep rooting species with rich leaf-fall, notably *Leguminosae*, can be considered, and so far for interplanting no better species is known than *Leucaena*. Various observations indicate that on infertile soils the thick undergrowth which has resulted from fire protection hinders the growth of the teak.

Natural regeneration of teak.—This only succeeds on good soils reasonably free from weed growth. Regeneration along irregular edges will fail if not trenched ; under a shelterwood natural regeneration will only be possible after a very heavy opening up of the canopy. Under present conditions in Java, natural regeneration of teak on a large scale cannot be justified.

H. G. C.

THE FINANCING OF AFFORESTATION, FLAX, TOBACCO AND TUNG OIL COMPANIES.

By H. Belshaw, M.A., Ph. D., and F. B. Stephens, M. A., B. Com.,—Auckland University College Bulletin, No. 22, June 1933.

(*Not for sale but may be had on application to the Auckland University Registrar*).

Most foresters have been asked at some time or other by their friends whether there is anything in the various commercial afforestation schemes with which New Zealand offers great riches to investors. Possibly those of us with a firm belief in the intrinsic value of forests—and he must be a poor sort of forester who lacks this!—have considered investment on our own account. It has been difficult however to reconcile the contradictory statements that one has heard—on the one hand one is warned solemnly against investing private money in afforestation schemes by wiseacre economists, and on the other, we have met hard-headed New Zealand and Australian business men who had placed much of their savings in long term forest investments. The solution to the riddle is to be found in this clearly written and obviously unbiassed pamphlet, which fully justifies one's faith in properly conducted forestry, but which condemns the scurrilous though apparently legal methods of certain of those "afforestation companies" to get ready cash from a gullible public. It is difficult, if not impossible, to save "the born gull from the born crook" but there is no doubt that if the author's recommendations were carried out and the Companies Act tightened up in various respects, there would be less heart-

burning amongst honest New Zealanders who see the fair name of their country dragged in the mud by disreputable financial concerns.

The chief point brought out is the vast difference between the "shares" and "bonds" offered by such concerns; the former are governed by fairly strict provisions of the Companies Act, but the latter are not. A *share* is part of the actual capital of a company, and when the public is invited to buy shares, the *prospectus* has to comply with the Act in disclosing certain information which should indicate the *bona fides* of the concern, while the directors or promoters are personally liable to pay compensation for any loss or damage which a subscriber may sustain through any untrue statement in the prospectus. A *bond* on the other hand is not a recognised term under Company Law and an invitation to buy bonds does not need to conform to a prospectus within the meaning of the Act. The directors of bond companies cannot be held personally liable for damages. The implications of these differences are obvious.

The worst type of company is where the commission agent earns a very large commission on any bonds he sells by peddling them from door to door, because a very large number of the victims are poor tradesmen and artisans who are persuaded to transfer their small savings from post office savings or savings bank deposits. Statistics produced show that the large majority of bond holders are of such a type and the ordinary investing public and reputable share dealers have very little to do with such concerns.

Another weakness in the present law which is apparently taken full advantage of is the wide facility for unloading land at enhanced prices from one company to another—one example being of typical pumice land worth £1 an acre for forestry and valueless for any other crop which after a few book transfers between parent and subsidiary companies, or between owner and company promoter (probably the same individual) is shown at £4 or £5 per acre. By this and various other means there are enormous profits to be made out of company promotion, and the fashion which started with promoting afforestation companies has spread to other faster-growing crops, such as flax, tobacco,

and *tung* oil trees, all of which are now being used in New Zealand as convenient lures for extracting money from the pockets of investors, as well as for real planting schemes.

With the development of a higher standard of agriculture in India and a growing incentive to invest money in local developments instead of hoarding it at home in hard cash, the opportunity for similar financial developments is now opening up. The research workers at the Forest Research Institute have recently dealt with a surprising number of enquiries from people who are thinking of taking up the commercial planting of such crops as bamboo, *semal* (*Bombax malabaricum*), *tung* oil trees, *balsa* wood, *Pinus insignis* (or rather *Pinus radiata*, as it is again to be called), *Acacias* for wattle bark, *Eucalyptus* for firewood plantations and so on. We would therefore recommend that the heads of provincial forest departments keep a weather eye on the operations of such commercial forestry efforts, as it would not be in the interests of any of us if this newly awakened interest of the Indian public in the commercial side of forestry were to be bludgeoned by unscrupulous company promoters masquerading as foresters. For any who have to deal with such problems, we would strongly recommend this excellent pamphlet, written as it is by two of the foremost economic students in New Zealand.

R. M. G.

MANUALS ON ENGINEERING AND SILVICULTURE IN URDU AND HINDI.

By M. Hakim-ud-Din, P. F. S.

To be had from the author, Forest Office, Chakrata (U. P.)

Mr. Hakim-ud-Din has done a great service both to the Forest Department and the public in general by writing a book on Elementary Engineering in Urdu and Hindi. Not only will it benefit the subordinates who cannot follow books written in English, but it will benefit the officers too for the time taken up in writing detailed orders to their subordinates for getting engineering works carried out can be saved for more important works.

We all know that the actual execution of most forest construction works proceeds generally under the direct supervision of subordinates, the majority of whom do not know English or possess the requisite knowledge for carrying out or supervising such works, and who depend solely upon the vernacular orders of their officers. With this book in hand every subordinate will be in a position to carry out engineering works properly and without waiting for very detailed instructions on minor engineering points from his officers.

The book is divided into five chapters dealing with Building material, Building construction, Roads, Bridges and Wells, and each one of these subjects has been dealt with fully. More than 100 diagrams have been included for the benefit of the reader. The book is the first of its kind and is written in simple language without the use of any high-sounding words. It is primarily meant for the use of subordinates and should therefore be judged from this standard. It could have been more concise but then it was no easy task to decide what to leave out and what not to. On the other hand, more detailed practical hints about certain things such as plastering, leeping, etc., could have been given. The collection and storage of building material before the actual work of construction is begun, the need for sharp tools, the organisation of labour and its control, although not strictly within the scope of the present work, would have formed a useful chapter. A few 'don'ts' about the use of blasting material are also desirable. The author has tried to keep the cost of the book within easy reach of men of ordinary means and so naturally such details have been left out.

The same author has also published an 'Elementary Silviculture' in Urdu and Hindi. In the words of the author this book has been written keeping in view the needs of students of the U. P. Forest Training Class. The book will prove of great help to all such subordinates in other provinces as well who cannot follow foreign languages but can read Urdu or Hindi. It is presented in a simple vernacular without the use of any difficult Persian or other words. In this small volume the author has done full justice to most of the subjects especially the chapter on thinnings.

A few more practical hints on planting such as the size of planting holes depending upon the root system of the species to be transplanted, the layout of roots in the hole, the position of the collar and the sloping of earth round the plant, etc., would have been desirable. A few lines on the 'stump' method of planting in any future edition will be very welcome.

The author is to be congratulated on having employed his rest periods after the hard day's work in the forest in doing a useful service to the Department and to others who have anything to do with the subjects.

P. N. DEOGUN.

FOREST-FIRE HAZARD RESEARCH.

By J. G. Wright, B.Sc.

(Department of Interior, Ottawa, Canada.)

This research was developed and conducted in mixed red and white pine forests in the Eastern Ontario and Western Quebec regions of Canada. The object was to endeavour to understand better the

phenomena relating to forest fires which, all will agree, is the most important branch of the science of forest protection in countries like Canada and India. The author has accordingly attempted by daily weather measurements and the preparation of curves or tables to arrive at units of fire hazard.

These units, when once known, are of great practical importance since such knowledge enables a Divisional Forest Officer to concentrate staff and make preparations in direct proportion to the hazards existing in the various localities of his division. Working in full sympathy with the territorial staff, the author has compiled most useful units of hazard which have doubtless already been welcomed and utilized by those whose duty it is to prevent fires breaking out and, if they do occur, to know how to deal with them in the most efficient manner.

It is hoped that the day is not far off when similar research will be begun in the several provinces of India; the divisions with the greatest hazards would have to be taken in hand first, results being recorded in the form of coloured divisional maps with a comprehensive set of symbols. How very useful would such maps be to Divisional Forest Officers, especially to those who have just taken over charge! It would not be long before such research proved remunerative because, firstly, it would automatically result in more efficient fire-protection and, secondly, expenditure on schemes and staff would be adjusted strictly in accordance with the degree of hazard existing in a particular tract of forest. In the absence of such research and fire-hazard maps can the following questions be satisfactorily answered by all Divisional Officers :—

(*a*) Do I really know the exact degree of hazard existing in each block during the fire-season?

(*b*) Am I distributing my special fire-staff in correct proportion to the various degrees of hazard present in my division? In other words, am I devoting insufficient attention to areas with high degrees of hazard and wasting money through over-concentration of staff in localities with a low hazard?

Many Divisional Officers will doubtless find such an introspection profitable.

During his research the author recognized the importance of inflammability zones; and he correctly concluded that the only way to arrive at such zonation was to measure the degree of combustibility of the leaf litter in different stands as it is the leaf litter in which fires spread. It is interesting to note that in a mixed forest of white and red pine fire will not spread when the moisture content of the leaf litter is 25 per cent or more. In India the leaf litter may vary very considerably in forests composed of different species. For example, a crop of *chir* pine (*Pinus longifolia*) always has a higher degree of hazard than is to be found in a stand of *ban* oak (*Quercus incana*). The hazard in the former is considerably increased by, firstly, a smaller moisture content and, secondly, the presence of resin in the dry needles. It is this peculiarly high hazard which is so well understood by territorial officers in the Punjab and the United Provinces that for many years past regular schemes have been in force for burning the leaf litter on a rotation of about three years in all areas not under regeneration ; the operation is carried out in winter according to a definite technique and has resulted in enormously reducing the fire hazard ; indeed, it is no exaggeration to say that this destruction of the leaf litter in a careful and cautious manner has proved to be the silvicultural salvation of the *chir* pine forests in the Kumaon circle of the United Provinces, thus preventing the holocausts of the past and so saving the government lakhs of rupees. In the Kumaon forests the technique of controlled burning has been further elaborated in order to destroy the leaf litter in areas under regeneration ; this treatment is applied as soon as the young *chir* pine crops are able to withstand a gentle downhill fire which stage is reached about the age of five years.

In classifying leaf litter the two important points to bear in mind are :—

(*a*) its ability quickly to start a fire, and

(*b*) having started one to spread it rapidly.

Rainfall, not so much the quantity as the manner of distribution over the fire-season, plays a vitally important role. The author's

research shows that mixed pine leaf litter absorbs moisture up to 270 per cent of its oven-dry weight before saturation.

The rate of evaporation is a factor which also influences greatly the inflammability of a forest. Two interesting charts exhibit the rate of drying and change of moisture content in the leaf litter. During research in India it should be possible to make known the different rates of evaporation for different ages and densities of stands of pure crops as well as for mixed. The rate of evaporation will also differ according to the silvicultural system applied. For example, the evaporation in forests treated according to the uniform system will be greater on the whole than in stands under the selection system. This subject of evaporation of forest fuels in relation to the fire hazard has sometimes been grievously lost sight of in forest management in India. For instance, in the silvicultural treatment of certain *sal* (*Shorea robusta*) forests the middle storey comprised of miscellaneous species has been ruthlessly cut out, thus greatly increasing the rate of evaporation and consequently the degree of hazard without any compensating silvicultural benefit.

When forest fire hazard research is begun in India, it will repay workers in this line to study Mr. Wright's book from beginning to end with especial reference to the technique employed.

J. E. C. TURNER.

WIRELESS FOR THE FOREST OFFICER—THE CHOICE OF A RECEIVER.

BY W. C. HART, P. F. S.

Having been a wireless "fan" (fanatic) for the past 2 years, I was interested in Mr. Hopkin's article in the July number of *The Indian Forester*.

I have obtained a considerable amount of pleasure from my set—also a four valve all wave set—which I have been improving and modernising. I must, however, warn prospective purchasers of receiving apparatus that for India nothing less than a four-valve all wave set will suffice, and that must be a modern up-to-date one, for the improvements in set design during the past 6 months have been unprecedented in the annals of wireless history. I refer chiefly to new all wave coils and the new "Class B" output valve, which tend to revolutionize set design. The radio firms in India are slow in grasping and incorporating in their locally built receivers new designs and components, one of the obvious reasons being apparently that they must clear old stocks first. So I sound a note of warning to be wary in avoiding an absolute "dud". Also do not buy a ready-built British, Continental or American built imported receiver, as the connections are usually soldered instead of being fixed by little nuts, the theoretical diagram is often not supplied, and the components are crowded together to economise space. All these are drawbacks which make it extremely difficult to locate and set right the little troubles that are apt to arise in the receiving set. It is called a "wireless" set, but do not stand aghast at the formidable array of wires that meets your eye. Each one has its use, and you just have to see that the various nuts are sufficiently tight to ensure the intended contract.

Personally, though I have expressed the opinion that nothing less than a 4-valve all wave set will suffice for India and as a forest officer, I would prefer a six valve battery-operated Super Het. with class B output, covering a wave length from 10 to about 500 to 600 metres, which will cover the principal stations of the world, and the Indian and Columbo stations.

India is a place of distances, and the Indian Broadcasting stations transmit their programmes at comparatively low power, from 2 to 3 kilowatts, compared with the 50 to 150 kilowatts of many of the European and American stations. The higher the power of a broadcasting station, the louder and clearer is the volume of sound and freedom from static or atmospheric disturbances, for which tropical

regions are notorious. Static noises are almost negligible on the "short waves". A Super Het will bring in European short wave stations better than a "straight" four valver, and this is the deciding point in the choice of a receiver in India, for as the power of the Indian Broadcasting stations is so weak, for 6 months in the year you will hear from them, if you are more than 200 miles away, less talk and music and more static.

Though you are a forest officer, avoid a "portable" set, for this usually has a built-in aerial and loud speaker. You will get much better results by using a separate loud speaker and tying a 75 foot aerial to a high tree. As your power will be obtained from dry batteries it will be too expensive to run a bigger set than a six valver.

The greatest delight I find in radio is from the Empire station at Daventry, from where good music and the latest news of the world (including Indian news) are heard daily. I receive the news in camp two to three days before they are seen in the newspapers, which is a great advantage to a man of the jungles. Wireless waves, *i.e.*, radio frequency waves, travel at the rate of 1,86,000 miles per second. If you are 6,000 miles away from a broadcasting station their programmes will reach you in 1/31 of a second ; whereas sound waves or audio frequency waves travel at about 1,200 feet per second. You will, therefore, hear Big Ben strike from London sooner than the report of a rifle 50 feet away.

SOUTH KURNOOL, 16*th July* 1933. W. C. HART.

EXTRACTS.

TAIWANIA IN BURMA—A NEW RECORD.

BY M. Y. ORR.

The peculiar monotypic genus *Taiwania* was found originally in Formosa in 1904, and was named and described by Hayata from material collected by Konishi on Mount Morrison. In 1916, Handel-Mazzetti discovered this Formosan conifer on the Salwin-Irrawaddy watershed in N. W. Yunnan, and from the same area further specimens were obtained by George Forrest in 1921. Prior to this, in 1918, Forrest found *Taiwania* growing in a mixed forest between Yung-chang and the Salwin river, some 200 miles south of the former locality. It was not known then to occur elsewhere, and the apparent restriction of *Taiwania* to the island of Formosa and to this part of Western China has been cited as a remarkable example of discontinuous distribution. In view of its comparative rarity in either country, a new record relating to *Taiwania* is worthy of note, particularly if this implies some extension of its former geographical range.

Some time ago, when examining material in the Herbarium of the Royal Botanic Garden, the writer discovered an unnamed specimen in the Burmese Collection of J. H. Lace which is undoubtedly referable to *Taiwania cryptomerioides*. This particular specimen (Lace No. 52), which consists of a sterile branch of what is described in the accompanying legend as a "large tree," was collected in the Myitkyina district of Upper Burma in September, 1912. The exact locality is given as "near Paypat bungalow," and the altitude indicated is "6,000 ft." Lace also mentions that the vernacular name of the tree is *shoak*.

Two interesting facts emerge with the disclosure of this herbarium sheet. One is the hitherto unsuspected fact that *Taiwania* had been found across the Burmese frontier so long ago as 1912, and growing, too, in a climate which is very different from that of its Formosan habitat, where it is relatively cool all the year round. The other point of interest is the date of collection of Lace's specimen, for it follows from this that *Taiwania* had been observed in Upper Burma prior to the time of its discovery in Western China.

(*Notes from the Royal Botanic Garden, Edinburgh, Vol. XVIII, Number LXXXVI, April,* 1933).

MADRAS FOREST COLLEGE PRIZE-GIVING.

The distribution of prizes and certificates to the twentieth batch of trained students of the Madras Forest College took place on the 1st July, 1933, the concluding day of the 'Forest College Week.' The Hon'ble Dewan Bahadur Sir Krishnan Nayar, Kt., the Law Member, presided. The students of the College furnished a guard of honour, which Sir Krishnan Nair, and Mr. A. Wimbush, the Chief Conservator, inspected.

Mr. J. C. Wrench, the Principal, in the course of his speech said :—

"Changes in the Staff at the beginning of the year brought us two new members, *viz.*, Mr. M. Kesavanunni Nayar and Mr. V. N. Seshagiri Rao. Since then Mr. Seshagiri Rao has had the title "Rao Saheb" conferred upon him, I understand,

for good work in the remoter parts of the Rampa Agency, and the college takes this opportunity to renew its congratulations.

"The year began with a total of 48 students: 19 Seniors and 29 Juniors. The Seniors were: 5 from Bombay, 5 from Central Provinces, 2 from Hyderabad, 7 State students (*viz.*, Dharampur, Jobat, Dhar, Bhopal and Travancore), and one private student from Madras, Madura. After an interval of 4 years, we welcome to the college, Madras government students. These number 12, obtained from the rank of foresters. These men might profitably be younger in age but it is trusted that they will make the most of the opportunity given them. The other seven students are from Coorg, Bombay, Hyderabad, Bhopai and 2 private students from Madras. To anticipate: we expect about 28 students from the 1st of August next making a total of 56. The recruitment in the case of Madras government students will be direct.

"With regard to discipline: the beginning of the year found us with the majority of the junior division made up of men from the Madras Service considerably older in age than usual. Such men could not but have found, at times, life at the college a little irksome after their former freer life. I should like to thank them now for their co-operation and to point out once again that discipline is necessary in order to live a fuller common life.

"Eighteen students sat for the Final Examination; of these one secured an Honours Standard Certificate and 17 Higher Standard. The college would like to take the opportunity to congratulate the winner of the Honours Certificate, Indra Narayan Dube from Central Provinces. It is recalled that 3 years have elapsed since the award of an Honours Certificate to a student.

"In hockey in October last, the college entered the local Athletic Association Hockey Tournament, and reached the semi-final. During the course of the year the college had nine fixtures with outside teams, of which five were lost and four won. In College Hockey Sixes, six teams participated.

"In cricket the college entered the local Y. M. C. A. Tournament but were beaten in two out of three matches. With outside teams eight matches were played, five lost, two won and one drawn. Many of the juniors of this year were introduced to this game for the first time.

"In the Grigg Sports in August last, the college won the aggregate cup for open events for the third successive year, and also the Individual Championship Medal, also for the third successive year. The College Athletic Sports were held in October, under favourable conditions and were well contested. The Richmond Cup for the highest aggregate score was won by a Senior Student. The Coimbatore Olympic Sports were held in February. The College entered for 14 events and were represented in the Finals in 9, the aggregate Championship Shield being well won by the Government College. The Cross Country Race was won by a junior student and he is to be congratulated on a well sustained effort.

"The estimate for electrification of the college and estate has been sanctioned and we expect electricity to be installed by the end of this financial year. "The question of supply of good water to the college seems solved by completion of the Siruvani Scheme, when it is hoped, the college will be included in the area supplied. The question is under correspondence.

"The college loses the service at the end of this term, of Mr. Ramachandra Rao who, after leave, returns to other duty. Mr. Ramachandra Rao has been associated with the college for 4 years, and I willingly take this opportunity to refer again to his unfailing interest and co-operation in college work and life and to thank him here, publicly.

LIST OF PASSED STUDENTS ARRANGED ACCORDING TO MARKS.

Honours :—

1. Indra Narayan Dube.

Higher Standard :—

2. Jageshwar Chintaman Sarwate.
3. Vijai Shanker Bihari Lall Sahu.
4. Kilimanoor Rama Varma.
5. Azzullah Sidiki.
6. Shankar Vithal Gulwadi.
7. Kunwar Narpat Singh.
8. Narayan Dattatraya Kalbag.
9. Bhimrao Vithal Patil.
10. Shafique Ahmed Farid.
11. Prabhakar Narayan Mulay.
12. Narayana Pillai Velayudhan Nair.
13. Himatsingh Urmedsingh Dasondi.
14. Abdul Ahad Khan.
15. Mohammed Saleh.
16. Thakka Ramaswamy Iyer Rajagopalan.
17. Ganesh Dattatraya Saranjame.
18. Mohammed Ahmed Khan.

PRIZES.

1.	Gold Medal for the best Senior student on marks ..	Indra Narayan Dube.
2.	Silver Medal for Honours ..	Indra Narayan Dube.
3.	Campbell-Walker Prize for the best student in Forestry (In Final Examination) ..	Indra Narayan Dube.
4.	Lodge Prize for Engineering ..	Indra Narayan Dube.
5.	Madras Conservators' Prize for Survey and Drawing (in Final Examination) ..	Indra Narayan Dube.
6.	Madras Conservators' Prize for Botany (in Final Examination) ..	Indra Narayan Dube, Jageshwar Chintaman Sarwate.
7.	Madras Conservators' Prize for Range Administration ..	Indra Narayan Dube.
8.	Brazier Prize for the student likely to make the best outdoor Ranger	Jageshwar Chintaman Sarwate.
9.	Chief Conservator's Prize for the best Junior Student ..	C. Sreedhara Mannadia.

10.	Richmond Cup to the student obtaining the greatest number of points in the more important events at College Sports ..	Jageshwar Chintaman Sarwate.
11.	Pentland Shield for the best all-round athlete ..	Jageshwar Chintaman Sarwate.
12.	Fischer Cup for Tennis ..	K. Krishnamurthi.
13.	Mannarghat Moopil Nayar Cup for Cross country race ..	N. C. Madappa.
14.	Cowley Brown Cup for Inter-Divisional Hockey ..	1932—34 Division (Junior).
15.	Hockey Sixes ..	(1931—33 Division).
16.	Swimming Medal ..	M. Narayana Nambiar.
17.	Winner of the best essay in the Madras Forest College Magazine for the year 1932-1933 ..	Shankar Vithal Gulwadi.
18.	Debating Society :—	
	Prizes—Extempore ..	Shankar Vithal Gulwadi.
	,, Prepared ..	Azzullah Sidiki.

After the distribution of prizes, Sir Krishnan Nair made a speech in the course of which, after congratulating the staff on the efficient working of the college, he said that till recently the very existence of the college was hanging in the balance. For some time past, owing to the existence of many supernumerary rangers in the Department, and in view of the fact that the reorganisation of the Department was under the consideration of the Government, very few of the Madras candidates were selected for training in the college. As a matter of fact, no Government students were deputed for training for 1930—32 and 1931—33 courses. The college was, therefore, working at less than its proper strength and the question was raised whether it was necessary for this Government to retain this institution for the benefit solely of other provinces and some of the Indian states. The question of the closure of the college was, therefore, carefully examined by the Government and it was finally decided that the institution must be retained. For the 1932—34 course, the Government had deputed 21 students selected from the ranks of foresters. In future, foresters would be eligible for promotion to the grade of rangers up to a limit of 5 per cent of the Rangers' cadre. The rangers' class in the Dehra Dun College had been temporarily closed by the Government of India and this college in Coimbatore was the only institution of its kind now functioning in the whole of India. This college might be expected to work the full complement of students in future and it might definitely be hoped that a new era of activity was in sight for this institution. There was a standing grievance among the rangers, namely, that there had been no promotion from their ranks to the gazetted ranks for a long time. It might be possible to redress this grievance when, as it was expected, recruitment to the grade of the Madras Forest Service was shortly recommenced and when the question of the future method of recruitment to this service was finally decided. As their Principal had said in his report, an estimate for more than Rs. 30,000 for the electrification of the college and the estate had been

sanctioned, and when electricity was installed, the amenities of college life, he need not say, would be considerably improved. He wished this institution, its staff and students luck and prosperity in the coming years.

Mr. A. Wimbush, the Chief Conservator of Forests then made a speech from which the following remarks are extracted :—

"The final examinations at the Forest College are held by forest officers with years of practical experience in the forest. These officers hold both written and oral examinations, and I wish to thank them for the trouble and care which they have taken in arriving at a true appreciation of the knowledge of the students. At least three of the examiners with previous experience of examining at the college are of opinion that the general standard of the outgoing class is rather below the average, although a study of the mark lists of the past 4 years would give the opposite impression.

"I have been very pleasantly impressed by the rejuvenating effect which a spell at the Forest College has already had upon the members of the Junior Division. Many of the junior students had put in years of hard work in the department before they were deputed to the college last year, and due to exceptional circumstances which will not recur, some of them were well over the normal age for entry to the college. After seeing these men beating their seniors in a very evenly contested hockey match last Monday, I no longer have any fears of their being too old to put in the allotted years of useful service in order to justify their deputation to the college.

"In conclusion, I wish to say a word or two about your Principal. Mr. Wrench has been at the Forest College for more than 3 years. During that time he has worked whole-heartedly for the good of the college. He is now proceeding on well-earned leave, and I am sure, that you will all join me in wishing him and Mrs. Wrench a very pleasant time at home and a safe return to renewed activities."

INSECT TRANSMISSION OF SANDAL SPIKE DISEASE.

The cause of the spike disease of sandal, which has seriously affected forest revenues in Southern India for more than thirty years, has eluded prolonged investigation. The work of Coleman in 1917 (*Bull. 3. Mycol. Ser., Dept. Agric., Mysore*) indicated that the causal organism was a filterable virus which was transmitted by insects, but the entomological investigations undertaken at the time were not productive. During the last five years studies by the Mysore Agricultural Department, the Indian Institute of Science, the Madras Forest Department, and the Forest Research Institute have confirmed and extended Coleman's conclusions and established the insect-borne nature of the disease.

Entomological work was commenced in 1930, as part of the programme of the Forest Research Institute, under the direction of Dr. C. F. C. Beeson, Forest Entomologist. Dr. Beeson felt that a careful quantitative survey of the insect fauna of sandal and associated plants would save much fruitless experimental endeavour, as an analysis of the morphological, ecological and numerical data so obtained would permit the selection of a small group of probable vectors when considered in relation to the peculiar characteristics of the disease and the factors affecting it. He also recognised

the fact that such a survey would provide a unique contribution to Indian entomology, as it would represent the first extensive study of the fauna of a single species of forest tree in the East.

The survey has been productive in both these respects. With the co-operation of numerous specialists a large number of systematic papers, incorporating description of new species, and data on distribution, host-plants, and seasonal and relative abundance, is in course of publication in the *Indian Forest Records*, while several papers on the morphology and bionomics of important sandal insects by Mr. N. C. Chatterjee (the officer in charge of most of the field work) are also in the press. Transmission studies were guided at an early stage of the enquiry by the selection of a small group of probable vectors and a critical discussion of the various hypotheses affecting the problem, a preliminary account being published by Mr. Cedric Dover in the *Indian Forest Records* early in 1932 (Vol. XVII, Part I). This paper began the series of reports on the entomological aspects of the problem of spike-disease and, with an introductory note by Dr. C. F. C. Beeson (Vol. XVII, Part IX), provides a more detailed description of the history, objects and general results of the enquiry than is possible here.

Among the insects suggested as probable vectors of the disease was an inconspicuous Jassid known as *Moonia albimaculata* Distant which Mr. Dover regarded, for reasons stated in his paper, as the most likely vector. Attention was also drawn to the importance of Aphids as likely carriers. Some argument attended the selection, but transmission studies have now supported it. A paper on insect transmission of spike-disease by Messrs. M. Appanna and C. Dover (which will be published shortly in the *Indian Forest Records*) shows that a large number of transmission experiments with a variety of suctorial and mandibulate insects was unproductive, whereas experiments with *Moonia albimaculata* yielded three positive results and produced symptoms in other cases which are regarded as likely to develop into those of typical spike. The three plants in which the symptoms of spike-disease have been produced by exposure to *Moonia albimaculata* are inseparable from typically spiked plants on symptomatic grounds, and samples from one of them have also answered important bio-chemical and cytological tests for the disease. The nitrogen content (which was tested by Mr. Y. V. S. Rao of the Indian Institute of Science) and the starch content were both much higher in the samples, as is generally the case in spiked plants, and the intracellular inclusions characteristic of spike and other virus diseases were also found in leaf-sections by Mr. M. J. Narasimhan of the Mysore Agricultural Department. The transmission by grafting of the symptoms produced by *Moonia* remain to be established, as grafting tests were only recently commenced. There appears to be little doubt, however, that the three infected plants are genuinely spiked.

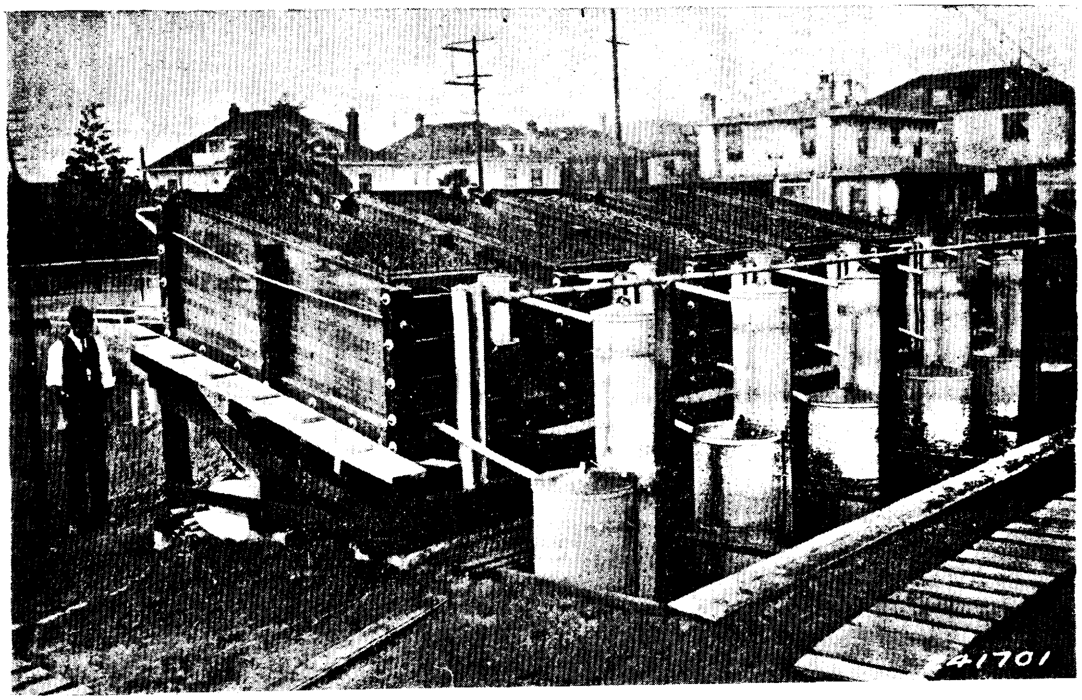
When the transmissibility of the disease produced by *Moonia* is established, it will bring to a close an important phase of the enquiry on spike-disease, as with the discovery of the insect transmitting it we shall be able to proceed to a critical study of the way in which it can be controlled. The incrimination of *Moonia* as the vector of spike is also of more academic interest, as spike-disease and peach yellows were until very recently regarded (Quanjer, *Phytopathology*, XXI, 1931) as exceptions in the

" yellow " group of viroses, the members of which are transmitted by grafting and suctorial insects, chiefly Jassids. Dr. L. C. Kunkel has recently established the fact that peach yellows is transmitted by the Jassid, *Macropsis trimaculata* (*Bull., Boyce Thompson Institute*, Vol. V, Part 1, 1933), and the present result therefore removes the last exception and makes the "yellows" diseases a compact group limited by well-defined characteristics. It is of interest to note here that Dr. Quanjer's paper and the work of Drs. K. M. Smith, L. O. Kunkel, and H. H. Storey indirectly but strongly influenced Mr. Dover's selection of probable vectors, and that the experimental programme owes much to their publications and support.

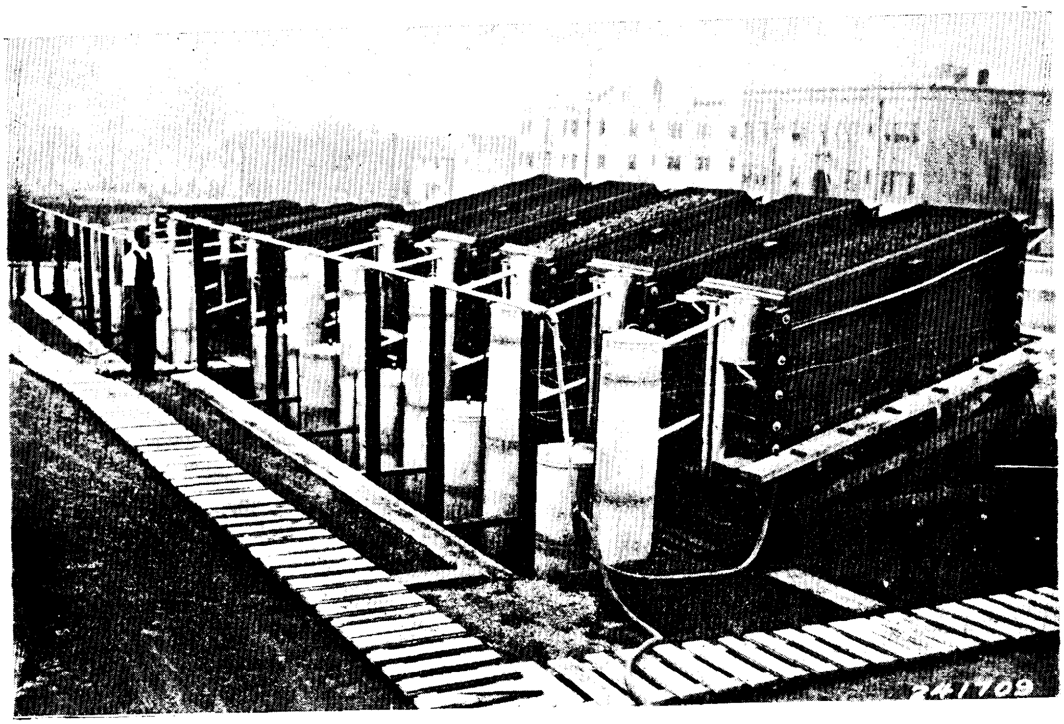
In so far as Aphids are concerned, only seven experiments were possible, one of which has yielded a result which is suspected to be positive. Unfortunately, this experiment was complicated by the presence of Thrips, but it is believed that these insects did not prejudice it as they lived only for a short time and the plant was not in flower. The result is being tested and further experiments are in progress but it is believed that even if Aphids are incriminated as vectors, they can only be regarded as of secondary importance in the spread of spike, as they are very rare on sandal. Moreover, Aphids appear to be peculiarly fitted for the transmission of virus diseases under experimental conditions (Smith, *Biol. Reviews*, VI, 1931).

These satisfactory results are the outcome of collaboration between several research organisations with the financial support of their respective governments. They have now to be translated into practical silviculture, and it is hoped that the forest departments interested will be able to allot the additional funds required for this purpose.

(*Copy of report submitted to the Editor of* Nature *for publication.*)



W. C. Lowdermilk, 1929.—View of soil erosion tanks—To study effect of gradient, on surficial run-off and erosion from bare soil surfaces. Berkeley University, California.



W. C. Lowdermilk, 1929. A view of the two installations of 5 tanks (lysimeters) each surface projection 20 square feet with 3′ profile. Device for overhead sprinkling to simulate rain is shown. Berkeley University, California.

INDIAN FORESTER.

NOVEMBER, 1933.

ASSESSING EROSION LOSSES.

Most of our readers are doubtless already convinced of the very serious losses of soil substance and of soil fertility caused by the rush of surface drainage resulting from heavy rain-storms, and in this note it is not proposed to repeat the familiar statements as to the seriousness of the erosion problem. As foresters we must all have realised at least some of its implications and are one and all prepared to admit an erosion problem of some kind or other in the Indian districts we are each familiar with. To the actual loss of fertile soil by surface erosion in both forestry and agricultural work, and the rapid deterioration in fertility which undue exposure of a naked soil brings about, must be added the less definite by none the less serious implications of deteriorating grazing and fodder reserves; flood damage along the course of streams; silting up of reservoirs, canal beds and agricultural lands; interference with water power installations and industrial water supplies; pollution of urban drinking water; and reduction in river transport facilities. The sum of all this damage must reach a fantastic total, but unfortunately those of us who appreciate its seriousness have no actual data or statistics to quote, while the general public are quite oblivious and are likely to remain so until more convincing facts and figures have been produced. There is thus a great need for reliable experimental data which can conveniently be divided into two groups :—

(1) assessing the economic loss from erosion in order to present the facts convincingly to the general public ;

(2) assessing the relative efficiency for counter-erosion value of the different local forest types and the effects of various forest operations such as fire protection, clear felling, *taungya* work, etc., for the professional guidance of foresters and planters.

Several recent publications deal with the subject of the measurement of soil erosion and the present note is written with a view to indicating the most interesting developments abroad and the very large gaps in our knowledge as regards Indian conditions. The best summary of the whole situation is a pamphlet *Soil Erosion* by T. Eden of the Tea Research Institute, Ceylon. (1) This very cheap little book should find a home in every divisional forest library and should be in the hands of every forest officer who values his professional reputation. It deals with the erosion question primarily from a British imperial point of view and points its moral for colonial and empire conditions; it is, therefore, rather astonishing that out of the 57 bibliographic references, 43 are American, while only 9 are imperial and 5 others foreign.

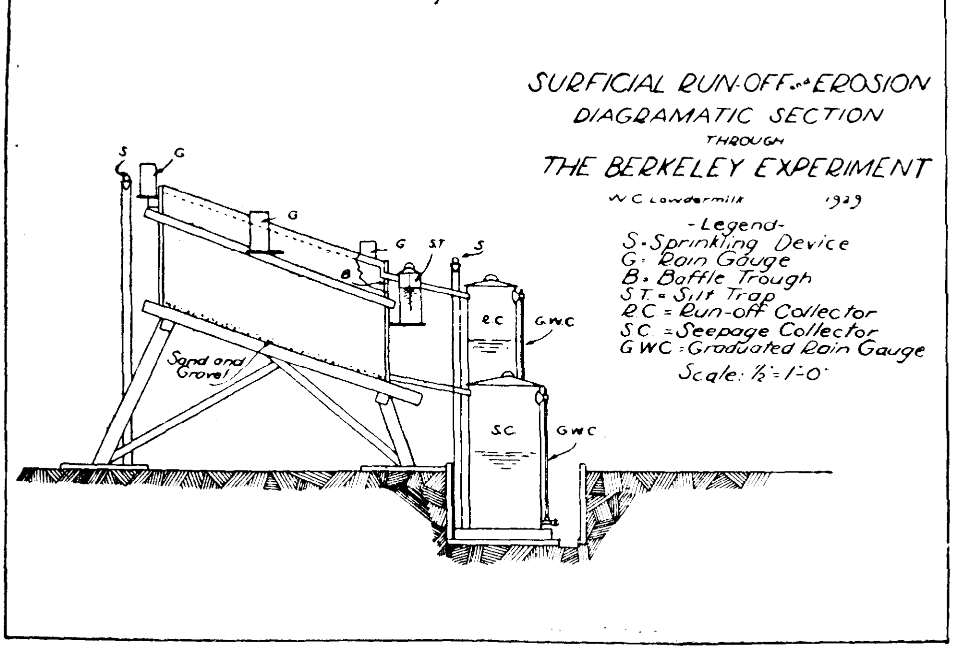
The most conclusive figures produced by any Empire workers are those from Ceylon where the 1931 report of a government committee on soil erosion (2) has opened up the way to collecting definite figures for both the vast quantity of valuable silt removed by the Ceylon rivers and the relative value of different ground cover-crops in the tea and other plantations. Loss of silt was measured in the Mahaweli Ganga on a bend of the river near the famous Peradeniya Botanic Gardens (3) and it was found that with a very low average velocity of 2·5 feet per second this river carried from 60 to 370 parts weight of silt per million of water, or in terms of annual loss of silt, 130,000 to 820,000 tons per annum. The detailed data show very clearly how rainfall in the catchment area a day or two prior to sampling increases the amount of silt. As one would expect, the amount of silt increases with the depth of water, the heaviest burden of silt and material being rolled along the river bottom, while the quantity of silt decreases a day or two after the rain has ceased.

A more recent experiment in Ceylon (4) has demonstrated that in steep tea land the soil losses amount to 17 tons per acre per annum where the land between the bushes is unprotected, while with a ground cover of *Indigofera endecaphylla* it was reduced to 9½ tons. In chemical values the unprotected ground loses heavily in nitrogen and organic matter contents, because the eroded soil is almost invariably richer in

fertilising constituents than is the parent soil from which it is extracted. This is a factor which should be kept in mind wherever *taungya* or other cultural work on slopes is likely to expose the soil for any considerable number of years. In intermittent cropping of soil which is normally under forest for long periods the loss through exposure is naturally not as serious as in the case of ground permanently under field crops, but in hill *taungyas* and in the huge stretches of *chir* pine now under a departmental burning programme which periodically destroys the natural soil cover, the amount of exposure should obviously be reduced as far as possible. This is brought out very forcibly by other foreign statistics now available.

Amongst the most interesting and accurate statistics produced in America are undoubtedly those produced by Dr. W. C. Lowdermilk at Berkeley University, California (5). Previous experience in China

Figure 1.



having convinced him of the seriousness of the problem, he evolved a tank apparatus to measure the comparative value of various types of ground cover from the local forests before and after the humus

layer had been destroyed by fire. We reproduce some of Dr. Lowdermilk's own photos from which the details can be seen. Each tank had 10 square feet surface with a depth of soil of 2½ feet. The bottom was packed with sand and gravel to allow rapid removal by percolation and to avoid difficulties due to a rising water table. The soils were packed in 4-inch layers in their natural sequence with the natural litter placed on the top. Artificial rain from a series of nozzles in zigzag formation 1 foot apart was sprayed on to the beds, and the amount of rainfall and its intensity were measured separately for each tank at 2 hour intervals, along with the data of silt carried away, rain water discharged from the surface, and seepage through the underlying layers of soil. 198 inches of artificial rain over a period of six months was applied in runs of from 1½ to eight hours' duration, the maximum being a "monsoon" of 80 inches of rain discharged in 10 runs of eight hours each in a period of 23 days. All of these tanks had been under a humus cover for a year before alternate tanks were burned bare with a blow-lamp torch; the removal of the litter caused an increase in erosion of 73, 160 and 1,196 times for the three different kinds of soil as shown below:—

Weights of soil eroded from plots protected by litter cover and plots burned bare on slopes of equal gradient and soils of three important types, under equal quantity and duration of artificial rainfall (Lowdermilk).

Time of run (hours).	Average total rainfall*	Sandy clay loam.		Fine sandy loam.		Clay loam.	
		Litter covered.	Bare.	Litter covered.	Bare.	Litter covered.	Bare.
	Inches.	Grams.	Grams	Grams.	Grams.	Grams.	Grams.
½ ..	7·86	0·05	18·6	2·00	234·0	0·51	285·4
1 ..	15·44	·40	40·6	1·70	646·8	·60	593·7
1½	21·45	2·00	38·2	·95	28·1	·44	1,279·4
2	20·17	·35	89·6	·59	235·6	2·02	1,238·2
4 ..	43·19	·45	35·4	2·48	19·0	·75	404·1
8	77·31	·50	48·6	1·07	235·6	·62	2,082·2
Average ..		·62	45·2	1·46	233·2	·82	980·5

* 10 runs made for each combination of time and condition.

Lowdermilk deduced the water holding capacity of forest litter to average eight times that of soil. The finer the texture of the underlying soil, the greater the protection given by the humus cover. Apart from actual retention of water, the humus has a further role of preventing the silting up of the pore spaces which occurs with the washing downwards of the finer soil fractions. Where a silted-up layer collects immediately below the surface of a bare soil, its effect is to choke back any further percolation towards the deeper layers. This percolation effect is quite as important a factor in the protective role of forest as is the mechanical sponge-like absorption of water and this has been verified by Lowdermilk in a further experiment with soil tubes in which he demonstrated that the rate of percolation of pure water is seriously interfered with after a solution of clay and silt particles has been percolated through any soil sample.

The usual classification of erosion falls under the heads of (*a*) *sheet erosion*, where the whole surface slowly loses in depth by surface washing, and (*b*) *gully erosion* which is an intensive localisation caused by the exposure and undercutting of sub-soil layers. The relationship of these two and just how far sheet erosion leads eventually to gullying are questions which have been examined by several workers, some saying that they are quite distinct and do not naturally follow in sequence. Lowdermilk traces a connection between sheet and gully erosion through the intermediate formation of an *erosion pavement*, consisting of the larger and more resistant fragments left after the more easily transported particles have been washed away. When this pavement stage has been reached, the soil is naturally lacking in nutritive value, but beyond this point there is little increase in erosion until the run-off acquires here and there sufficient force to move and break up the pavement. When this scouring action once sets in, it is amazing how rapidly deep gullying develops.

Lowdermilk used his tank apparatus for collecting data on the related question of the effect of gradient upon the intensity of run-off and erosion. Setting his tanks at various angles of five per cent and upwards from the horizontal, he concluded that where the soil surface is bare and other conditions uniform, the actual slope becomes of

less importance when the rain intensity is high; slopes of 6 to 23 per cent (1 in 10 to 1 in 4) showed no appreciable difference in percentage run-off under rain intensities exceeding the maximum percolation rate. The relation between gradient and erosion is however quite different; with increase in slope, erosion is much exaggerated and the erosion pavement stage is reached much more rapidly on steeper ground. Further work with the same type of tank has been correlated with field plot measurements by other American workers (6):—

Effect of gradient on run-off and erosion with rainfall of one inch per hour (Duley and Hayes).

Type of soil.	Slope.	Average run-off per cent.	Eroded soil lbs. per acre.	Run-off lbs. per lb. of soil transported.
Silty clay loam ..	0	33·85	117·6	651
	2	63·47	392·0	367
	4	68·86	616·4	253
	8	73·28	2,561·3	65
	15	83·48	7,821·2	24
Sandy loam ..	0·5	68·36	195·4	792·5
	2	70·80	113·1	1,417·4
	4	75·73	191·6	895·1
	8	78·41	993·0	178·8
	16	78·61	25,175·5	7·1

The striking feature of these results is that run-off and erosion behave so differently. In both soils run-off increases with the first increments of slope and then tends towards a constant value; erosion on the other hand is only moderate in amount below 4 per cent gradient (1 in 25) but as slopes become steeper than this, a very rapid increase is produced. A comparison of the two soils shows that for gentle slopes the sandy soil is less erosive than the clay, but at steeper slopes, the position is very definitely reversed. This reversal complicates the problems of classifying soils as erosive and non-erosive. The explanation apparently is that run-off from gentle slopes can more easily transport the very fine particles of clay than the heavier grains of sand,

while at the higher velocities achieved on steeper slopes, the loosely bound sand particles move more easily than does the more closely compacted clay. A comparison of these factors for some Indian soils such as laterite and black cotton soil would be of very vital interest.

The question of assessing the counter-erosion value of our Indian forests is one which ought to be taken up without further delay. We know that they are absolutely invaluable but have we any facts and figures to persuade the unbeliever? Again America has set us the example. We have just received from Mr. E. N. Munns, Chief of Silvicultural Research in the United States, a most valuable paper of which he is part author (7). This gives a summary of all the available statistics on erosion and the factors which exaggerate it, then proceeds to classify in detail the watershed protection value of all the United States forests. The whole country is divided into 17 main drainage basins, each of which is discussed under a number of heads; climate and topography are briefly outlined, then the local watershed problems are analysed under such heads as urban water supplies; water power; silting of river channels used for navigation; floods; erosion affecting agricultural cultivation; ownership of the land; logging and disforestation; grazing and utilisation of waste land; abandoned agricultural holdings on marginal land which has been wrongly disforested. In a country as large and as varied as the United States each locality has its own peculiar problems such as the gullying of the Mississipi uplands, the huge tracts of abandoned farmlands in the central states, sand movement on the coastal dunes, neglected areas of privately owned forest which have been exhausted by intensive logging and left derelict, the ravined country of the Arkansas and Missouri "badlands", the over-grazing of the semi-desert "chaparral", and the pressing need to conserve the water supplies nearest to the major manufacturing districts. Many of these have exact parallels under Indian conditions and a similar reconnaissance of Indian watershed conditions would be of great value, for the assessment of economic losses from erosion is the first step towards a sane and constructive policy in dealing with this menace. We have already got local reports on erosion for certain parts of India. Messrs. Coventry,

Holland and Glover have brought Punjab conditions before the public (8). The counter-erosion work on the ravined lands at Etawah in the United Provinces is well known (9). But these are isolated instances and we require action on a broader and more national basis if this great evil is to be efficiently dealt with.

The book under discussion closes with recommendations for a programme which will deal adequately with the situation and doubtless the awakening consciousness of the United States to its seriousness will support the drastic action which the government of that country is now contemplating. The action proposed falls under the following heads:—better fire protection for inflammable forests; the replacement of clear felling by selective logging; large scale public acquisition of areas requiring restoration of cover, including the acquiring of 155 million acres for control and the afforestation of 11 million acres out of this; drastic reduction of grazing on areas which are suffering from over-grazing and the revegetation of selected grasslands; intensive engineering works such as flumes and check-walls where ravining is serious; and the improvement of agricultural methods by terracing and contour ploughing to reduce erosion of fields. Just how far such operations would be desirable or justified for Indian conditions, it is impossible to say until we have a more accurate assessment of the damage actually taking place throughout India to-day.

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A NEW BURMESE BAMBOO.

By C. E. Parkinson, Forest Botanist, F. R. I.

DENDROCHLOA C. E. Parkinson, genus novum. Spiculae 5—7-florae, rachilla articulata, inter lemmas pedicellata, floribus hermaphroditis; glumae inferiores steriles, rigidae, mucronatae; lemma (gluma florens) rigida, arcte convoluta, multinervis, aristomucronata; palea lemmae aequilonga vel longior, bicarinata, apice obscure bidentata; lodiculae 3, magnae, subaequales, margine ciliolatae; stamina 6, unum liberum, caetera filamentis duobus et tribus ultra medium connata; ovarium in stylum elongatum attenuatum, stylus apice obscure 3-fidus. Caryopsis magna, ellipsocylindrica, apice stylo persistente coronata, lemma paleaque inclusa, pericarpio semini adherente.

Gramen arboreum elatum, caules laxe caespitosi, internodia longissima. Folia ampla, venulis transversis sub-conspicuis. Flores in culmis foliiferis in paniculis terminalibus ad nodos ramulorum ferentes.

Species unica, in Burma indigena.

Dendrochloa distans C. E. Parkinson, species nova. Culmus arboreus erectus, 15-20 m. altus, ad 11 cm. diametro, inferne nudus, internodia 1·2-1·5 m. longa et ultra, nitida, parietes 5 mm. crassi; spathis magnis, basi 24-30 cm. latis, 35-50 cm. longis, extus pilis pallidis adpressis hirsutis, intus glabris et nitidis; lamina imperfecta 35-50 cm. longa, basi dilatata 5-10 cm. lata, supra basim abrupte attenuata, apice sensim longe acuminata; ligula irregulariter. Folia magna, 30-50 cm. longa, 5-9 cm. lata, lineari-lanceolata, apice longe

acuminata, basi subrotunda vel parum attenuata in petiolum 1 cm. longum, supra glabra, subtus pallida et adpresso-pubescentia vel demum glabrata, margine scabra, nervis secundariis utrinque 15-16, haud conspicuis, venulis transversis inconspicuis et remotiusculis; vagina adpresso-hirsuta, demum glabra, ore efimbriata, ligula erecta et conspicua, obtusa, 3-7 mm. longa. Panicula terminalis usque 75 cm. longis, basi foliiferis, spiculis verticellatis per intervalla 5-6 cm. ad nodos locatis, internodiis breviter hirsutis; glumae inferiores vacuae 3-10 mm. longae. Flores 5-7; rachilla inter lemmas 2 cm. longa, sursum sensim dilatata et dorso-compressa; lemma 2-2·4 cm. longa, 1 cm. lata, rigida et arcte convoluta, margine supra medium ciliata, mox glabrata; palea 2·6 cm. longa, 1·1 cm. lata, convoluta, carinas 2 apice versus ciliatis, inter carinas 6-nervia et inter carinas et margines utrinque 5-nervia: lodiculae 1-1·2 cm. longae, angustae obovato-oblongae, hyalinae, inconspicue nervosae; filamentae 2·6 cm. longae, antheris 1·4 cm. longis, apice obtusis; ovarium glabrum, stylus 3-3·5 cm. longus. Caryopsis 2 cm. longa, 6 mm. diametro.

Lower Burma. Mergui district; forests near Theindaw and Tharabwin on the Big Tenasserim river.

Tamyin chaung, Theindaw, *Maung Po Khant* 13286 (type), fl. 11th January 1932; *Maung Po Khant* 13430, fl. and fr. 4th May 1932. Tharabwin chaungbya, *Maung Po Khant* 13269, *Sakoe* 10158, with leaves and culm sheaths only.

Burmese names *Tamyinwa* and *Kamyinwa*.

This remarkably fine bamboo grows in considerable patches in the forests near the old town of Tenasserim, at Tharabwin, Sindin, Theindaw and elsewhere. It forms loose clumps of about 15 to 20 culms 1 to 4 feet apart and is remarkable in having the longest internodes of any Burmese bamboo, or perhaps of any known bamboo, the writer having measured a culm 14 inches in girth with the internodes 5 feet 11 inches distant. It is to this character that the specific name refers. Its leaves are also large, one specimen measuring 2 feet long and 3½ inches wide, and as far as the Burmese species are concerned are comparable in size only with those of the climbing bamboo *Neohouzeaua helferi*.

In addition to the characters given above, it may also be easily recognised in the field by the very characteristic sudden narrowing of the imperfect blade of the culm sheath not far above the wide base, to form a long tapering dagger-like point. It is used locally for making rafts and the mat walls of houses and is well known locally by the Burmese names given.

With regard to the systematic position of the species, it must, on account of its six stamens, 2-keeled palea and the pericarp being adherent to the seed be placed in the *Eubambuseae*. Its long spikelets and large florets are unlike those of any other species in this group and the manner in which the six stamens are united by their filaments is very distinctive. It possesses some characters suggestive of the *Arundinarieae*, such as the minute transverse veinlets in the leaves and the long spikelets with distant florets, but from the characters given above it cannot be considered as belonging to that group.

Plate 1.—Fig. 1, flowering branch; 2, culm sheath with imperfect blade; 3, floret; 4, lemma; 5, palea; 6, lodicule; 7, fruit enclosed in the persistent lemma and palea with part of the rachilla attached. Figs. 1 and 2 about one-fourth actual size; 3, 4, 5 and 7 about actual size; 6 about twice actual size.

THE LIABILITY OF SOLID BAMBOO LANCE STAVES TO ATTACK BY BORERS.

The following report was lately compiled by the Forest Entomologist, as a result of long series of experiments carried out by the Entomological, Chemical, Timber Testing, Wood Preservation, and Minor Forest Products laboratories. It may be emphasised that the acceptance of a specified maximum number of holes per piece of bamboo (or per internode) is the same as accepting bamboos "immune from attack" in the consumer's sense. If bamboos are felled at the right time, extracted quickly, treated with antiseptics, inspected frequently and treated again with antiseptics if borer holes appear, borer damage will be reduced to a commercially negligible amount.

H. TROTTER, FOREST ECONOMIST.
C. F. C. BEESON, FOREST ENTOMOLOGIST.

Felling Period.—The best time to fell bamboos is when the liability to attack by borers is least. The liability is least during the period mid-October to end of December, and again from mid-June to end of

July in the western United Provinces; and during the period end of October to beginning of January and again in May—June in the Punjab. The hot weather period, however, is one in which contractors ordinarily do not work and is therefore of no practical value. Bamboos felled at other times in the year are much more liable to attack. This does not mean that all will be attacked, in fact the probability is that 20 to 60 per cent will escape attack. Felling when the moon is at its full or during the new moon phase makes no difference.

Specification for Lance Staves.—The ordnance specification for lance staves lays down that they should be free from borer holes, and the presence of one hole is sufficient to ensure rejection. This specification is fallacious, being based on the misconception that a borer hole is an indication of existing or potential weakness. On the contrary the presence of borer holes *in small numbers* indicates a bamboo resistant to borer attack, whereas a bamboo without holes may or may not be resistant. This paradox is explainable by reference to the habit of the beetle of sampling bamboos indiscriminately and after making a hole 1/16″ to ¼ of an inch deep, abandoning a bamboo that is unsuitable for its development.

The strength tests for static bending and impact bending of lance staves carried out by the Timber Testing Section, Forest Research Institute, show clearly that the strength of a solid bamboo varies greatly and quite independently of the presence of borer holes in small numbers. Bamboos with a moderate number of holes were found to be stronger than bamboos with a small number of holes or with none at all. Bamboos with no holes were found to vary from very strong to relatively very weak.

I recommend, therefore, that the specification should be reviewed to allow the acceptance of staves containing borer holes *in small numbers*, which may be defined for practical purposes, as a maximum of 10 holes per stave or 2 holes per internode. A borer hole may be defined as one with a depth not exceeding ¼ of an inch and producing no dust if poked with a pin. The factor of safety here is very high, as on the average a distinct loss of strength does not appear until the number of borer holes approaches 200 per stave. This specification

should reduce considerably the price at which contractors can supply staves, as by felling at the prescribed period two-thirds of their yield will be up to standard.

Storage.—There is practically no difference in the liability to attack of bamboos stored in the sun or stored in the shade. Under average conditions sixty per cent of bamboos stored without special protection should be sound at the end of two years.

Antiseptic Treatment.—If bamboos with ten holes and less are accepted, there should be no need for antiseptic treatment as a preliminary to storage, since such bamboos have been sampled and rejected by the beetle and are immune for the future. Bamboos without holes on the other hand are always open to suspicion unless reliable evidence can be given by the contractor that they were felled in the post-monsoon months. We have moreover no information that the safe felling period for north India is applicable to conditions in south and central India.

Treatment with sodium fluoride by the open tank method as specified by the Wood Preservation Section of the Forest Research Institute ensures absorption of the antiseptic at the cut ends and the trimmed nodes. It does not entirely prevent the boring in by beetles on the internodal surface, where two bamboos are in contact. If lance staves are stored in creosoted racks so that there is no contact of bamboo to bamboo, there is no danger of damage. If they are stored tied up in bundles or in loose heaps, further protection is required in depots where the danger of borer attack is known to persist. In borer-infested depots the sodium fluoride tank treatment of stock should be repeated in January each year.

In depots where small stocks are held or there are no facilities for tank treatment, efficient protection can be obtained by wrapping bundles of a score or so in paper and sealing with gum or glue, *not* flour paste. Lance staves issued and taken into use after they have been in store for some time do not require any special protective treatment.

Tent and Telephone Poles.—The presence of borer holes in tent and telephone poles of solid or of hollow bamboo does not affect the strength below certain limits. For practical purposes a maximum of ten holes in any one internode at the time of purchase may be allowed

provided the poles are antiseptically treated shortly afterwards. The presence of holes ensures better penetration by the antiseptic. If no antiseptic treatment is adopted, the maximum permissible number of holes per internode should be reduced to two.

What has been said about the storage of lances applies also to the storage of tent poles. If untreated poles are attacked while in store they will develop new holes after about six months. Poles that have been in stock for more than six months and show not more than 10 holes in any one internode may be safely issued for use.

CONTROL OF LANTANA: A SUGGESTION.

By E. K. Krishnan, P. F. S., Madras.

Readers in South India are aware of the enormous damage caused to grazing grounds, fuel and sandal forests by the invasion of *Lantana*. Various measures have been taken from time to time by hosts of forest officers and others interested in the study to combat the spread of this pest but *Lantana* has not only withstood these attacks but has actually gained ground in recent times in localities where it did not exist previously. Chemicals and poisons used in the hope of eradicating it have perhaps caused a temporary set-back in its growth in the areas experimented with, but have failed to deal the death blow to its vigorous vitality.

During recent times the success attained in the eradication of prickly pear with the cochineal insect has turned entomologists' attention to the discovery of some insects partial to *Lantana* and though experiments conducted with the *Lantana* seed-fly (*Agromyza lantanae*) raise hopes of checking the alarming spread of *Lantana*; it will be some time before conclusive evidence is forthcoming of the suitability and the feasibility of this mode of attack in the forests in India now overrun with *Lantana*.

The writer of this article has made an observation in the forests of the Mysore plateau, where he is stationed and where *Lantana* is unusually prolific, that *Dodonaea viscosa* is probably inimical to the growth or at least to the spread of *Lantana*. He has observed that where *Dodonaea viscosa* is already in possession of the soil, *Lantana* is noticeably scarce, that where *Lantana* and *Dodonaea viscosa* grow

together, the density of growth of *Lantana* is markedly poor, and that unless the odds are terribly against *Dodonaea*, it is able to hold its own and make some headway through an otherwise impenetrable cover of *Lantana*. Is this observation borne out in other localities and will forest and other departmental officers who have facilities for observing these two shrubs growing side by side, kindly make their experience known in the columns of this journal in support or otherwise of this observation?

There is ample evidence in nature—at least in the writer's experience—of fire-line and reserve boundaries, where once *Lantana* made impenetrable thickets, gradually opening out by the invasion of *Dodonaea viscosa*. This is particularly noticeable in Jowlagiri reserve forest in North Salem forest division in Madras presidency, where an area burnt in 1925 which originally carried a fairly heavy crop of *Lantana* is now completely occupied by *Dodonaea*.

If further observations of other officers tend to strengthen the view that *Dodonaea viscosa* is a probable enemy to the growth of *Lantana*, we have a cheap and easy method of tackling the vexed problem of *Lantana* eradication. It might perhaps be possible to initiate experiments in different localities through the agency of Provincial Forest Research officers and Silviculturists to test the truth of the theory now advanced. The writer himself is attempting on a small scale to put his theory to the test of practical proof and hopes to give his readers an account of the results of his tests in a later article.

The following experiments suggest themselves to him:—

(1) to pass a fire through a dense *Lantana* area and introduce *Dodonaea viscosa* in the burnt area.

(2) to treat a *Dodonaea viscosa* area similarly and introduce *Lantana* in it.

(3) to grow *Lantana* and *Dodonaea viscosa* together in one plot and note the preponderance of the one or the other species periodically. As definite conclusions from these experiments can be drawn only after a lapse of some considerable time, it is suggested that research officers might interest themselves in the problem and make their observations known.

THE UTILIZATION OF BAGASSE FOR THE PAPER AND BOARD INDUSTRIES.

BY

M. P. BHARGAVA, M.SC., OFFICER IN CHARGE, PAPER PULP SECTION, FOREST RESEARCH INSTITUTE, DEHRA DUN.

In recent years the sugar industry has grown rapidly in this country. The bulk of bagasse, which is the refuse of cane left after crushing the sugar from cane in the factories, is burnt as fuel. It is claimed that this practice results in a considerable reduction or even elimination of the quantity of coal required to operate the factories. In the *International Sugar Journal* for August 1929, Mr. E. L. Squires states "apparently bagasse is a very high priced fuel and it might be better to burn the sugar." High freight rates on coal, coupled with the absence of a demand for bagasse for a better purpose are probably responsible for the general practice obtaining in the sugar factories.

Investigations carried out in the past on bagasse indicate the possibility of putting it to various profitable uses, the most important of which are its utilization for the production of papers, purified cellulose and fibre boards.

The cellulose content in bagasse is between 40 and 50%. A good deal of this is, however, lost in the mechanical and chemical processes employed in its preparation, with the result that the yield of bleached cellulose is very low, being on the average about 25—28%. In view of this low yield and of the harsh and "rattly" texture of paper prepared from bagasse cellulose, it has not been found feasible to utilise it for the manufacture of high grades of paper. However, by adopting slightly less drastic chemical processes, it is possible to obtain from bagasse 31—32% of bleached cellulose which, being not very clean, is suitable, in admixture with bamboo or grass cellulose, for the production of inferior grades of paper (bleached and badami), large quantities of which are consumed in this country.

Experiments carried out at the Imperial Institute, London, show that cellulose suitable for artificial silk can also be prepared from

bagasse. So far as is known, however, commercial success has not yet been attained in its utilization for this purpose, although in 1928 a firm in Cuba had put on the market a cellulose, which was claimed to be suitable for use in the manufacture of paper and in the artificial silk industry. The question is still being investigated by the Hawaiian Sugar Planters' Association. As other suitable raw materials, *e. g.*, bamboos, grasses, etc., are available in plenty in this country, which may be utilised for the manufacture of paper and of cellulose for artificial silk, the utilization of bagasse for these products may be ruled out of consideration.

During the last decade the production of packing papers and fibre boards from bagasse has been considerably developed in the United States of America and in other sugar cane producing countries. The Celotex Co., Louisiana, uses enormous quantities of bagasse, obtained from Cuba, for the manufacture of insulation and structural boards, panel boards, corrugated boards, wrapping papers, etc. The output of boards alone by this firm increased from 18 million square feet in 1922 to over 500 million square feet in 1930. In the early stages of the industry, difficulties were encountered in the removal of large quantities of bulky material produced during the short crushing season of 60—90 days and due to its spontaneous combustion during storage for the remainder of the year. These have been overcome by using specially designed heavy balers and by giving preliminary chemical treatment to the material to prevent its decomposition. In Cuba, the sugar cane crushers have been able to dispose of the bagasse at a fair profit, as they also find that the efficiency of their boilers has increased by replacing bagasse furnaces with suitable oil burning equipments.

It will be clear from the above that the uses to which bagasse can be put in this country are :—

(1) in the manufacture of inferior grades of paper, and

(2) for the manufacture of packing papers and fibre boards.

The market for the latter products and the price at which bagasse can be available will, however, determine the feasibility of employing the material on a commercial scale for these uses.

Market for packing papers.—Imports of packing papers, old newspapers, paste boards, mill boards, etc., into this country in 1929-30 and 1931-32 are given in the following table :—

	Tons.		*Value in rupees.*	
	1929-30.	1931-32.	1929-30.	1931-32.
Packing paper ..	14,343	10,241	49,59,234	31,31,016
Old newspapers ..	45,631	41,857	45,99,002	34,51,608
Straw Boards ..	12,991	9,873	16,66,500	11,68,054
Paste boards, Mill boards, etc.	745	372	4,40,868	3,30,330

Presumably a large proportion of imported old newspapers is used for packing purposes by the retail trade. The total consumption of packing papers may, therefore, be taken at about 40,000 tons per annum. Old newspapers are no doubt cheaper than packing papers but their use for wrapping foodstuffs, etc., is unhygienic. The retail trade is, however, slowly taking to the use of packing papers for wrapping and packing purposes. With some propaganda work it is possible to induce the trade to use cleaner packing papers in place of old newspapers. Further the sugar industry itself can consume a large quantity of packing papers in the form of paper bags. The present practice in sugar factories is to pack and despatch sugar in gunny bags. Short fibres and dirt from these bags get mixed up with sugar. These are not only a nuisance to consumers but lower the value of the sugar. The gunny bags can be lined with paper bags at a very low cost. The paper bag will keep the sugar clean and at the same time protect it from atmospheric moisture. Again in the retail trade small quantities of sugar can be sold in paper bags instead of in the more expensive cloth bags as is sometimes done at present. An experiment recently carried out at the Forest Research Institute indicates that a packing paper with satisfactory tensile and bursting

strengths can be produced from bagasse, particularly if a small percentage (15-20%) of bamboo or some other long fibre is mixed with it. A market for packing papers, therefore, already exists in the country and bids fair to grow considerably in the near future. At present packing paper is not manufactured at all in the country. There is, therefore, a promising field for the utilization of bagasse for this new industry.

Market for fibre boards.—During the last few years the use of fibre boards for structural, insulation and multifarious other purposes has grown rapidly and extensively in western countries. It appears improbable that the use of boards will be equally extensive in this country, due to the peculiar climatic conditions and the availability of a number of cheap structural materials. It is, however, likely that a fairly large demand for fibre boards (pressed and insulation) may grow up in this country for certain special requirements, *e. g.*:—

(1) In large office buildings, on floors and ceilings for sound and heat insulation.

(2) In theatre and cinema halls, on walls, floors and ceilings to obtain perfect acoustics or to correct defective acoustics.

(3) In factories for sound proofing or vibration proofing of machinery.

(4) In the construction of cool chambers, ice-chests, refrigerators, refrigerating railway cars, etc.

(5) In the construction of motor car bodies and similar constructional work where strength and ability to withstand vibration, combined with lightness, is required.

(6) In the manufacture of boxes, *e.g.*, fibre board trunks, suit cases, attaché cases, card-board boxes of various shapes and sizes for medicinal phials, card-board boxes for packing a host of small manufactured articles—soaps, scents, stationery, hosiery, glassware, laboratory apparatus, chemicals, etc., etc. For some of the above uses strawboard is at present used. In view of the fact, however, that cereal straws are not available at cheap prices in this country, except in a few localities, it appears that boards made from bagasse, may

successfully compete with and replace straw boards in many of the above uses. It appears, therefore, that there is a large potential market for fibre boards also in this country.

Price of bagasse.—As mentioned above the bulk of bagasse is burnt as fuel in the sugar factories. The calorific value of dry bagasse is about 8,000 B. T. U., while that of average anthracite coal is 12,000—14,000 B. T. U. In other words about $1\frac{1}{2}$ tons of dry bagasse is equivalent in heat value to 1 ton of coal. Taking Rs. 10 to 12 as the average cost of one ton of coal in localities where a large number of the sugar factories are situated (eastern parts of the United Provinces and Bihar and Orissa), the minimum price at which sugar factories may part with bagasse comes to about Rs. 7 to 8 per ton of dry bagasse. To this must be added the cost of handling and transporting bagasse from the sugar factories to the paper or board mills. Since bagasse is a very bulky material, it is obvious that it would be economic to locate the paper or board mill as close as possible to the sugar factories so that transportation charges may be reduced to the very minimum. Taking on the average Rs. 4 to 5 per ton as the cost of handling and transporting bagasse from sugar factories to the paper mill, the minimum price of dry bagasse, delivered at the mill site comes to about Rs. 12/- per ton.

Taking into consideration the current prices of bamboo, grasses or straw, it appears that at the above price bagasse may compete favourably with them as a raw material for the production of packing papers or for utilization in the manufacture of inferior grades of papers from bamboos and grasses. An approximate estimate of the cost of production of packing papers also shows that the manufacture of these papers from bagasse, at Rs. 12/- per ton, may be about as remunerative as the production of ordinary grades of writing and printing papers from bamboo or grass. It may, however, be mentioned that this statement is based on the results of only a few experiments carried out at the Forest Research Institute, Dehra Dun. A detailed and systematic investigation of the material appears to be necessary in order to correctly assess its worth as a raw material for the packing paper and board industries and for determining the maximum price which these industries can afford to pay for it.

It will be seen from the previous table that packing papers, old newspapers and boards worth more than a crore of rupees per annum are imported into this country. With the development of industries in the country and a rise in the standard of living, consumption of packing papers and boards is bound to increase considerably in the near future. The possibility of utilising bagasse for the manufacture of these products appears promising, the two important conditions necessary for success being (1) that bagasse should be available at prices which bear the same relation to the costs of coal (f. o. r. sugar factories) as the calorific values of the two materials bear to each other and (2) that paper or board mills should be situated in the vicinity of sugar factories so that the handling and transportation charges may be reduced to the minimum. The application of bagasse to the manufacture of papers and boards will make a more economic use of the material than burning it as fuel, encourage the growth of a new industry, and render the country independent of imports of these products from foreign countries.

THE X-RAY INTERPRETATION OF FIBRE STRUCTURE.

By W. T. Astbury, M. A., of the Textile Physics Laboratory, Leeds University (Extracts from the Society of Dyers and Colourists Journal, June 1933).

When the structure of matter is examined by the methods of X-ray analysis, eyes of physical apparatus and the brain of mathematical physics are employed to look at objects which fall below the limits of ordinary human vision. The two processes, X-ray analysis and vision, although so different in actual practice, are essentially similar in theory, for both depend on the scattering or "diffraction" of ether waves by the bodies under examination, followed by reasoning, conscious or sub-conscious, as to the nature of the diffracting bodies from that of the diffracted waves. In the case of vision, so-called "visible" light * and the physical apparatus of the eye are used,

*The wave-lengths of the waves of visible light *viz.*, red, orange, yellow, green, blue and violet, extend from about 8,000 Angstrom units to about 4,000 Angstrom units, that of the yellow sodium light, *e.g.*, being 5,893 Angstrom units. An Angstrom unit of length is one hundred millionth cm.

and the form of the waves which flow through the pupil and lens on to the retina is "interpreted" by the brain automatically—if the experimenter has no anatomical or mental defect—as something which is regarded as the "truth," but which frequently enough is otherwise. Similarly in the case of X-ray analysis* the ether waves of short wave length called X-rays, which do not excite the sensation of vision when they fall on the retina, are used to register the diffracted waves on a photographic plate or by other physical means, and on the results argument is based as to the form and nature of the bodies which diffracted the waves. Thus, as before, the process is subject to limitations of various kinds, both mental and experimental, and the purpose of this paper is to outline what has been learnt so far, sketching the picture formed in the mind when the interior of a textile fibre is lit up by X-rays.

The object of using X-rays instead of, or rather in addition to, visible light is, of course, to extend the range of vision, *i.e.*, to permit objects which are far too small to be seen by the human eye, even with the aid of the most powerful microscope, to be viewed at least mentally. Just as ripples are seriously distorted by pebbles which would be far too small to disturb the form of ocean waves, so X-rays, some ten thousand times shorter in wave-length than visible light, are seriously distorted by atoms and molecules which are far too small to disturb the main form of waves of visible light. Things are "seen" through the waves which are thrown back from the body looked at, and only such irregularities can be distinguished as are not much smaller than the wave length of the waves used, because irregularities which are negligible compared with the waves make negligible impressions on them. The most carefully machined and polished surface is quite rough from the molecular point of view, even though by ordinary light it may appear so perfect as to be "optically flat;" but by using smaller and smaller wave-lengths, smaller and smaller irregularities can be detected until, finally, in the "light" of the X-rays, after making the appropriate

* The X-ray analysis discussed here has nothing to do with the radiology or radiography of hospital practice. X-rays have the power of penetrating bodies which may be opaque to visible light, and a hospital X-ray photograph is simply a shadowgraph formed by interposing bodies of various densities in the path of the X-ray beam.

calculations, the shapes of the atoms and molecules themselves can be distinguished.

The detection of mere irregularities as such is not, however, of any great use. What must be searched for, if the dimensions of atoms and molecules and the way they fit together are to be determined, are the hidden *regularities* in the structure of matter. It seems clear therefore from this standpoint, that solids might prove considerably more helpful than liquids or gases, because in the latter there is little or no firm or permanent attachment between the molecules, so that at the best no more than average dimensions can be expected to be deduced. This is, in fact, the case, for when a parallel beam* of monochromatic, or approximately monochromatic, X-rays is passed through, *e.g.*, a drop of water, there is recorded on the photographic plate only a diffuse ring like the corona formed by clouds passing in front of the moon, or when a light is viewed through a misty window pane. Just as from the size of the corona the average size of the water-drops in the cloud can be calculated, so from the size of the ring on the photographic plate an estimate can be formed of the average distance of separation of the water molecules in the liquid drop. An X-ray photograph of this kind may be termed an "amorphous" photograph; it is typical of liquids and gases, *but of very few solids*. One of the solids giving such an amorphous photograph is ordinary, *unstretched*, India-rubber [Fig. 1 (*a*)], and from it may be inferred the most probable distance of separation of the long chains of polymerised isoprene, which form the bulk of the rubber substance. (Plate 32.).

If the India-rubber (actually a common elastic band for the X-ray photographs shown) is stretched to several times its original length, and then another photograph is taken under similar conditions, a totally different result is obtained [Fig. 1 (*b*)]. The new photograph is a regular diffraction *pattern of "spots," i. e.*, something definitely more specialised and instructive than the ill-defined halo of the first photograph, something which is an expression of the fact that stretched India-rubber is in a higher state of organisation than unstretched rubber, and is, in fact, "crystalline."

* The X-ray beams used in these experiments are about as thick as a needle. They are defined and made approximately parallel by means of a long fine tunnel drilled out of some dense metal or alloy.

Thus, as would be expected from our knowledge of vision and visible light, an X-ray photograph is a diffraction picture portraying, although indirectly, the state of organisation of the body photographed, and further, since the X-ray wave-lengths are so short, the state of *molecular organisation.* There are possibly innumerable types and degrees of organisation in material structures, but it is most convenient to refer them all to the *crystalline state.* The crystalline condition may be fairly called the "natural" state of solid matter, on account of the almost universal tendency of molecules on solidification to settle down, not in irregular heaps, but in regular and often highly symmetrical aggregates which are simply three-dimensional, or space, patterns analogous in every way to the familiar flat, or two-dimensional, patterns of the textile industries. This is a very fortunate circumstance in the application of the principles of X-ray analysis, for it means that if the forms and dimensions of the molecular pattern underlying the crystal architecture of the substance which gives rise to that pattern can be deduced from the X-ray diffraction picture,* as theoretically should be possible, then conclusions can be drawn as to the form and dimensions of the molecules themselves, because *the dimensions of a pattern are the expression of the dimensions of the units from which it is built.* From X-ray photographs of loose and ill-defined molecular aggregates, such as are found in liquids and gases, only the average molecular dimensions can be deduced; but from the photographs of the regular molecular aggregates which are the crystals of the solid state, given sufficient experimental data, the detailed molecular dimensions and the way the molecules fit together can be deduced.

The properties of an aggregate are compounded not only of the properties of the individual units, but also of the way in which they are put together. The evolution of this process can now be traced right from the electrical constitution of atoms up to the structure of matter in bulk; and the region in which X-ray analysis is most valuable

* The X-ray diffraction photograph of any substance is characteristic of that substance. Although it resembles nothing that can be seen by eye, it is the physical basis of the mental picture formed, after making the necessary calculations, of the invisible molecules. X-ray analysis thus offers a powerful means of identification of minute quantities of matter without resort to destructive chemical analysis.

X-RAY PHOTOGRAPHS.

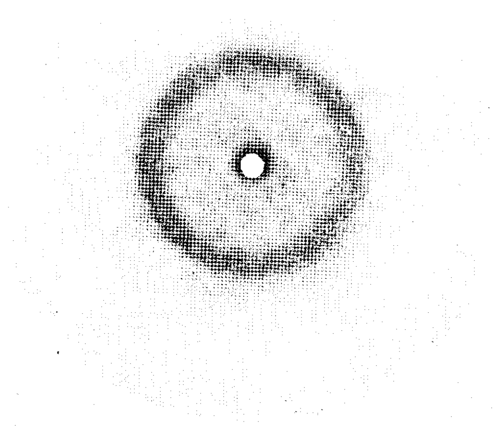

Fig. 1 (*a*). An unstretched elastic indiarubber band.

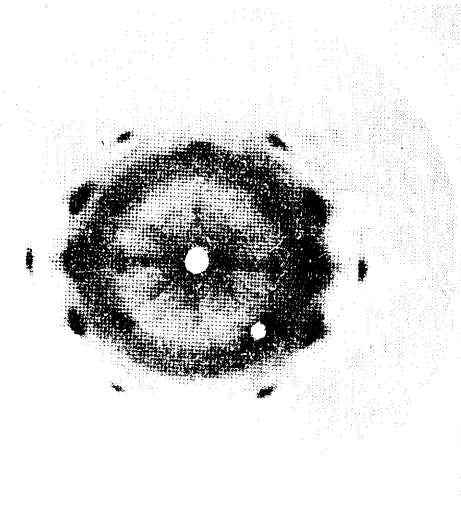

Fig. 1 (*b*). The same indiarubber band stretched to seven times its original length.

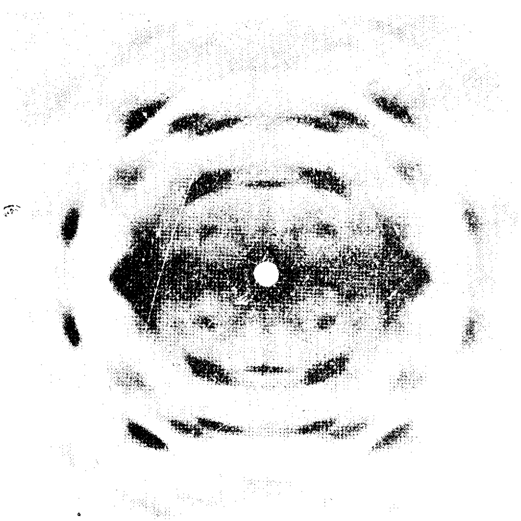

Fig. 3. Native cellulose fibre (ramie).

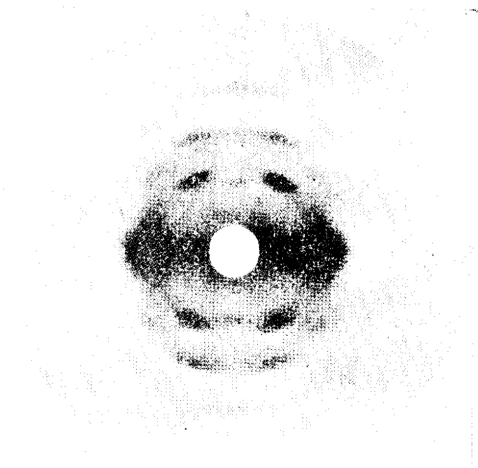

Fig. 4. Mercerised cellulose fibre (a regenerated cellulose artificial silk).

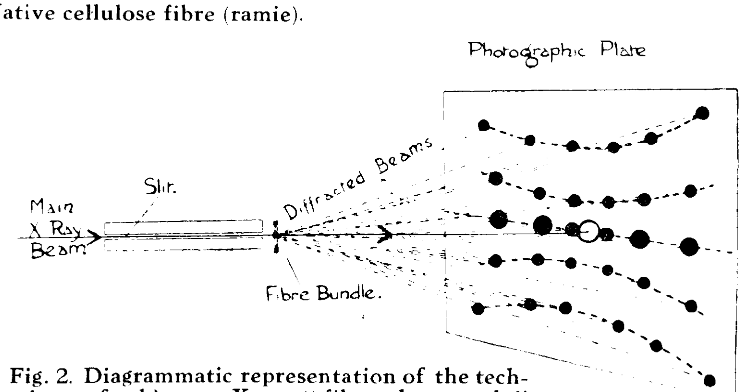

Fig. 2. Diagrammatic representation of the technique of taking an X-ray "fibre photograph."

Astbury : Society of Dyers and Colourists Journal.

comprises (1) the formation of molecules from atoms, (2) the formation of crystals from molecules, and (3) the formation of crystal aggregates from minute crystals. Expressed more precisely, this means that it is possible, by X-ray methods, not merely to analyse the individual crystals, but to determine their size and mutual arrangement in a poly-crystalline mass. At first sight it might appear rather hopeless to apply these ideas to the intimate structure of textile fibres, since no crystals at all are revealed by direct optical examination. It must be remembered, however, that there is a considerable gap between the limits of ordinary vision and those of X-ray vision, a gap representing the domain of "colloidal" particles, in which there is ample room for *sub-microscopic* crystals, and these must disclose themselves immediately to X-ray examination. This is exactly what happens in the X-ray analysis of fibre structure,* and it is seen at once that *the molecules of textile fibres are aggregated into crystalline, or pseudo-crystalline, groups* from the constitution and orientation of which conclusions of prime importance can be drawn.

Typical X-ray "fibre photographs," as they are called, are taken after the manner shown diagrammatically in Fig. 2. They are all, to a certain extent at least, "spot" photographs, and as such indicate the indubitable presence in the fibre substance of matter in the crystalline state, but the state of crystallinity is by no means perfect, for the best X-ray photographs of biological subjects are distinctly "poor" as compared with corresponding photographs of common laboratory crystals. All these photographs however have two features in common, *viz.*, similarity of crystal size and shape, and well-defined selective orientation, *i.e.*, they show that *the sub-microscopic crystalline aggregates formed by the fibre molecules are long and thin, and lie with their long axes either all roughly parallel to the fibre axis (ramie, silk, animal hairs), or arranged so as to form a spiral round the fibre axis (cotton).* (The cellulose crystallites in ramie really form a spiral as in cotton, but the spiral is so steep that for most practical purposes it may be said that they lie roughly parallel to the fibre axis).

* Since results rather than methods are discussed here, this is not the place to enter into the details of X-ray technique. It is sufficient for the present purpose to refer to Fig. 2 to gain a working idea of the general method of procedure. It will be seen that in principle at least this is not at all complicated.

PHYSICAL STRUCTURE OF COAL, CELLULOSE FIBRE, AND WOOD AS SHOWN BY SPIERER LENS.

BY REINHARDT THIESSEN. PITTSBURGH EXPERIMENT STATION, U. S. BUREAU OF MINES, PITTSBURGH, PA. (EXTRACTS FROM INDUSTRIAL AND ENGINEERING CHEMISTRY, SEPTEMBER 1932).

That coal is a colloid has been accepted for some time, and many of the phenomena related to its uses have been laid to its colloidal nature, such as theories of plastic flow, agglutination, behaviour in coking, etc. Examinations of very small particles by ordinary ultra-microscopic means have shown that coal particles are composed of ultra-miscroscopic particles or micelles but have given no idea of their size and arrangement in the coal structure.

Recently Spierer, a Swiss physicist, introduced a new type of lens involving the principle that light reflected by colloidal particles is greatest opposite the direction of the illuminating ray. With this new tool the study of the colloidal nature of coal and other organic substances related to coal was resumed with unexpected results. Not only was the colloidal structure of coal shown but also the arrangement of the micelles and their relationship to that of the original arrangement in the living plant from which they were derived.

Structure of Sound Coniferous Wood.—The wood of ordinary conifers, such as pine, hemlock, spruce and balsam, consists of long hollow boxlike fibres, running parallel to the long axis of the stem, arranged in concentric layers or rings from the centre of the stem outwards, and further arranged in tiers radiating from the centre to the periphery. In a transverse section the cut ends of the fibres present roughly rectangular outlines. The wall of a wood fibre is said to consist of three or four layers: the middle lamella, the primary layer, the secondary layer, and the tertiary layer. It is a difficult matter to distinguish between these layers since, generally, variations from a few to a number of layers may be seen in the transverse section. Fig 6, a transverse section of the stem of a *Microcycas*, is a good type to illustrate the various layers. (Plate 33.)

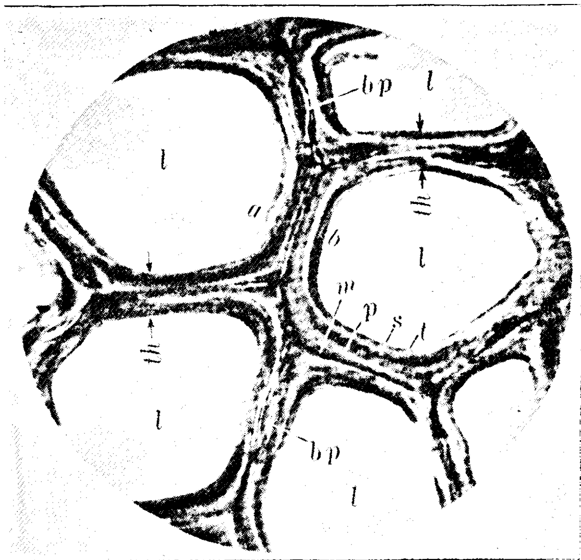

Fig. 6. Thin Transverse Section of Wood of *Microcycas* Stem Taken with 2-mm. Oil-Immersion Apochromatic Objective to Show Layering of Wood Fibres Usually Described.

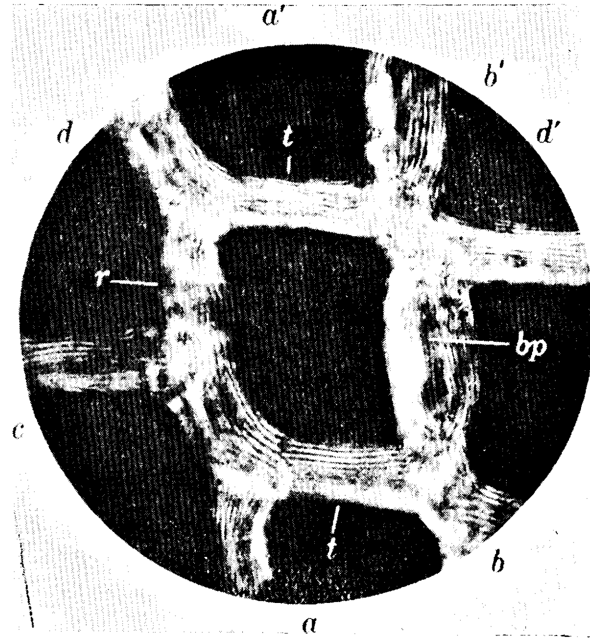

Fig. 7. Transverse Section of Balsam Fir Taken with Spierer Lens.
r. Radial wall.
t. Tangential wall.
bp. Bordered pit in tangential wall.

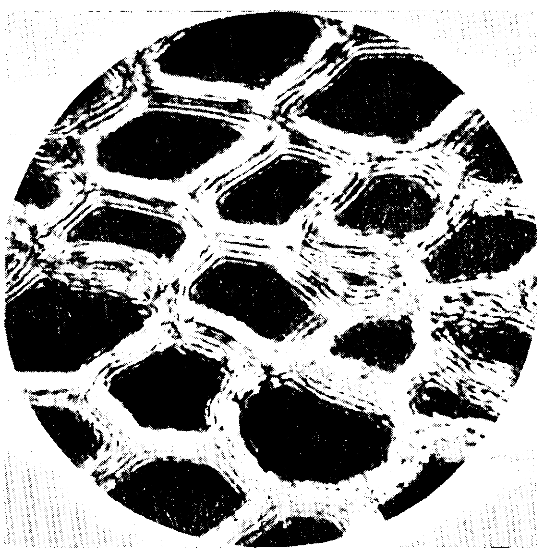

Fig. 10. Transverse Section of White Cedar in First Stages of Decay, Taken with Spierer Lens (× 1000).

Fig. 12. Transverse Section of Coniferous Wood in Advanced Stage of Decay (× 1000).
Thiessen : Industrial and Engineering Chemistry.

The thickness of the walls, *th*, varies in this case between 9 to 13 microns or 90,000 to 130,000 A°. (A° is an Angstrom unit of length =one hundred millionth cm.) The cells or fibres are separated from one another by a very thin layer—the middle lamellum, *m*. It is composed essentially of lignin and stands out sharply from the other part of the wall, staining blue with a safranin-gentian violet stain. The middle lamellum is bounded on either side by a thin layer—the primary layer, *p*. This layer is also relatively thin. It may be distinguished from the other layers by its lighter colour. Next follows the relatively thick secondary layer, *s*, and then, against the lumen, *l*, comes the tertiary layer, *t*. Bordered pits are shown as *bp*. In many fibres these layers may be distinguished clearly. More often, however, there is a distinct repetition, and the specific layers, whether primary, secondary, or tertiary, cannot be determined, as is shown in the wall between *a* and *b*.

The primary, secondary, and tertiary layers are composed essentially of cellulose (approximately 50 per cent.), lignin (approximately 30 per cent.), and hemicellulose (approximately 20 per cent.).

Nature and Structure of Lignin.—Since lignin is universally associated with cellulose in wood (the two being regarded as lignocellulose), its nature and structure must be taken into consideration.

While the chemical nature of cellulose is quite well-known, that of lignin is still far from being solved; although the physical structure of the cellulose fibre, such as cotton and ramie, is also well-known through X-ray methods, the knowledge of that of wood is far from being satisfactory. The relationship of the cellulose and lignin in wood, although much discussed, is yet unsolved. Lignin is generally considered to be amorphous, giving diffraction patterns with only one or two diffuse rings. Hess says that all modern refined methods of investigation show that in the cell wall cellulose is not chemically bound to its other components. Herzog and Jancke reason from X-ray data that the lignin is not chemically combined with the cellulose crystallites but is absorbed on the surface of the cellulose crystals or layered between the crystal particles.

Freudenberg and co-workers maintain that the lignin shows no indication of double refraction, either with the polarising microscope or with X-ray methods. Lignin in wood, he says, exists in the form of a fundamental amorphous medium to be compared with a mass of felt in which the cellulose crystallites are embedded. After the removal of the cellulose micelles, as by the sulphuric acid method, the crystallites leave oblong vacant spaces in the lignin. These vacant spaces hold tangential positions parallel to the cross section of the fibre. The vacant spaces are the cause of weak double refraction, which is the same as that claimed by other investigators to be true double refraction of lignin. Chemically, they say, lignin must be considered as formed in two stages. The fundamental molecule of lignin is that of a coniferyl alcohol. On the average, twelve such molecules are combined through condensation into polymers. These polymers are in the form of chains, approximately 100A°. in length. At the death of the plant, or when attacked by chemical reagents, these chains are further combined by condensation or polymerization into larger aggregates. These aggregates should be visible under the ultra-microscope.

Comparison of Cellulose and Wood Fibres.—A comparison of the structure of the cellulose fibre, such as cotton and ramie, with that of wood shows that they are essentially the same, except in the width of the spacing of the striae. The distance in the cellulose fibre is approximately 0·833 micron, whereas that of wood is 1 micron. In the cotton and ramie fibres where there is no lignin, the striae are produced by the cellulose micelles alone ; in the wood fibre they must be produced either by the cellulose micelles alone or by micelles consisting of both cellulose and lignin. If the lignin is amorphous and consists of ultra-particles, it should be visible under the ultra-microscope. But neither the cellulose nor the lignin (or, in other words, the lignocellulose) is visible in any part of the cell wall when seen in the direction at right angles to its surface. The way in which the two are related, whether chemically combined or merely physically associated, becomes a vital question. The distance between the striae of 0·833 micron in the cellulose fibre, and of 1 micron in wood allows

for the additional lignin in wood. If the chains in the cellulose fibre (giving rise to the striae in the cellulose fibre) consist of square columns, the areas of the cross section of these are 825^2 or 680,625 square millimicrons: those in wood are $1,000^2$ or 1,000,000 square millimicrons. Therefore, if 68+represents the total cellulose units in cotton, then 100+represents the total cellulose plus lignin in wood. This is about the ratio actually found.

Perhaps more may be learned concerning their relationship in the study of progressive decay by micro-organisms or by the removal of either the cellulose or lignin from wood by chemical means. The chemical changes from sound to well-rotted wood have been studied for some time, and many data are available. The cellulose and the hemicellulose disappear rapidly in rotting wood under favourable conditions whereas most of the lignin remains and becomes transformed into a substance termed "humins." Well-rotted wood is largely soluble in hot solutions of alkalies and leaves but little cellulose; the solution is colloidal and generally called "humic acids.."

Micellar Structure of Slightly Rotted Wood.—Thin sections, both transverse and longitudinal, were prepared from a piece of slightly rotted coniferous wood taken from peat. Figure 10 shows a transverse section. The striations appear more definite and give to a much larger degree the appearance of being formed by oblong micelles placed end to end. The farther or flat side of the lumina of the fibres—that is, the tangentially cut part of the fibre—is no longer entirely invisible, but certain more or less defined striae are here discernible and seem to be arranged in definite spirals. The slight rotting of the wood has changed its physical nature, and the walls at right angles to the rays of the light have also become visible.

Micellar Structure of Wood in more Advanced Stage of Decay.—A number of fragments of dicotyledonous and coniferous woods in a more advanced stage of decomposition were examined, both in transverse and longitudinal sections. Figure 12 shows a transverse section of the conifer, including part of the spring and part of the autumn wood. The spring wood is in a greater state of disorganization than the autumn wood. In the autumn wood the orderly arrangement of the striae is

preserved to some extent, while in the more disorganised spring wood the striations have been distorted but an orderly micellar structure is shown. In radial as well as in tangential sections of the same fragment [not reproduced—Ed.] the entire walls are shown to consist of well-segregated colloidal particles or micelles. It is clearly shown that, although the wood is in an advanced stage of decay and contains relatively little cellulose, the micelles, even though isolated to a far greater degree, have retained much of their original relative location. In the transverse sections they are seen to be still arranged concentrically. In the longitudinal section they are now definitely shown to be oblong and arranged in striae, end to end. Wherever it was possible to measure the distance between the concentric rings in the transverse section, or the distances between the striae in the longitudinal sections they were found to be one micron as in the sound wood. The tangential walls, or those parts of walls facing the observer, are now perfectly visible, and are seen to be composed of oblong micelles.

If it is assumed that the mass of rotted wood is derived largely from the lignin and that the cellulose has almost disappeared in the process of rotting, the micelles derived from lignin still hold similar positions. In slightly rotted wood the structure is the same as in sound wood, except that the striation and segregation are more distinct. In tracing from this stage to that of thoroughly decomposed wood, the structure, or the order and arrangement of the structure, is still the same as it was in the sound or slightly rotted wood. There must exist therefore some close relationship between the cellulose and lignin.

The structure of pine wood from which the cellulose has been removed remains to be examined. The cellulose in wood may be removed without entirely destroying its structure. Thin transverse sections, approximately 40 microns in thickness, were cut from white pine. The oils, resins, and hemicelluloses having been removed, the sections were treated by the well-known Schweitzer's methods to remove the cellulose. After this treatment the sections had suffered considerable tearing, disintegration, and shrinking, but were sufficiently intact for examination and photography. Under the micro-

scope such sections have a yellow appearance and resemble sections of well-rotted coniferous wood in structure. In a Spierer photograph of a transverse section of a white pine from which the cellulose has been removed by cuprammonia, so that only lignin remains, the resemblance to that of rotted wood is clearly shown. Again it is seen that the sections consist of micelles arranged much the same as in rotted and sound wood. Therefore some relationship must have existed between the lignin and cellulose in order that the lignin retain the same general line-up as the cellulose.

EXTRACTS.

FORESTRY AND FOREST RESEARCH.

BY A. D. BLASCHECK, F. C. H., OEC D., INSPECTOR-GENERAL OF FORESTS. (Reprinted from *The Times of India of 16th September.*)

India has a wonderful asset in her forests, and now enjoys the results of some 70 years regulated utilisation of their produce and development of their yield. Lord Dalhousie inaugurated a permanent forest policy in 1855 and the start made in Burma and Madras was soon followed by the organisation of a forest department of government in other provinces. In 1894, as a result of experience gained, the Government of India issued a detailed statement of their forest policy : a resolution made liberal recognition of the claims of local villagers to forest produce, and largely confined protective measures to forests which provide a valuable supply of timber, or which for one or other reason should not be denuded. This policy still holds good and on occasion, owing to the wider interests involved and the possible sacrifice of deferred benefits for immediate gains, its maintenance has been recognised as the concern of the central government.

There is a greater variety of climate in India than in any other country of the same size in the world, and in consequence most types of forests are represented. The rainfall varies from a few inches in Upper Sind to nearly 500 inches per annum at Cherrapunji in the Assam hills, and temperatures vary between extremes of approximately 25° and 125° F. Different combination of these climatic conditions is primarily responsible for the natural distribution of forest types such as the damp tropical evergreen forests of Bengal, Assam, Burma and South India, the more open and drier forests throughout the country which are more or less leafless at some time of the year, the thorny scrub forest bordering on the deserts, the temperate hill forests, and the alpine forests of the Himalaya. The seasonal distribution of rainfall, geological formation and nature of the soil account for further differentiation of types, some of

which are quite distinct and well defined, while others merge into each other. The chief zones of evergreen forest lie on the west coast of the peninsula, in Assam and Bengal, in Burma and the Andaman Islands. The humidity and comparatively even temperature of these tropical and sub-tropical localities favour dense growth of a variety of trees and under-growth. Many of the trees attain a height approaching 200 feet and proportionate girth, but most of them are as yet of little value. Deciduous forest is widely distributed throughout India and Burma, but as a consequence of less favourable conditions, neither the variety of trees nor the density of the forests is so great, and fires have often helped to determine the nature of the crop. Both the teak (*Tectona grandis*) and the *sal* (*Shorea robusta*), two of India's most important trees, grow in this type of forest: natural teak forest is more or less confined to the peninsula south of Jhansi and in Burma to between latitudes 16 and 25° N., while *sal* forest is found north of the teak zone and in the sub-mountain country, but in India only. The hill forests grow throughout the Himalaya and in the adjoining ranges of the North-West Frontier Province and Burma, but the most valuable are those of the Western Himalaya where the deodar (*Cedrus deodara*) grows; a number of pines, firs, spruce and other trees closely related to those in Europe cover many of the hill slopes. A dry forest zone with very limited flora and poor tree groth occupies the plains of the Punjab and adjoining parts of Rajputana and Sind, and in this area large quantities of timber and firewood are now grown in irrigated plantations. Other distinct types of forest grow on the sea coast and in the estuaries of rivers which are submerged at high tide, while riverain and swamp forests are widely distributed.

The area of forest under the control of the Forest Department is nearly 250,000 square miles or 22 per cent. of the total area of British India. Much of this forest is at present unprofitable or is waste providing only for the local population, but 113,000 square miles are closely protected, and 80,000 square miles of forest are managed in accordance with working plans which provide for a sustained yield of timber and other produce. The areas of "Reserved" and "Protected" forest in the several provinces is as follows:—

Bengal	..	7,234	square	miles.
United Provinces	..	5,199	,,	,,
Punjab	..	4,757	,,	,,
Burma with Federated Shan States	..	34,449	,,	,,
Bihar and Orissa	..	3,015	,,	,,
Assam	..	6,145	,,	,,
Central Provinces	..	19,613	,,	,,
Coorg	..	537	,,	,,
North-West Frontier Province	..	245	,,	,,
Ajmer	..	142	,,	,,
Baluchistan	..	316	,,	,,
Andamans	..	52	,,	,,
Madras	..	16,070	,,	,,
Bombay	..	14,868	,,	,,
Total	..	112,642	square	miles.

In addition to the government forests of British India, there are large areas of forest in some of the States and considerable areas privately owned.

Forest administration now rests with the provinces and in Bombay, Burma and the North-West Frontier Province it has been transferred to a Minister responsible to the Provincial Council. The special forest laws are sometimes of local application only, but they are mostly based on the Indian Forest Act of 1878. At first only a few trained forest officers were employed, but from 1866 onwards arrangements were made to train the controlling staff in Europe. Courses were taken in France and Germany, then at the Royal Indian Engineering College, Coopers Hill, and later at Oxford, Cambridge and Edinburgh universities. From 1926 to 1932 a higher course of training at Dehra Dun took the place of that provided for the Provincial Forest Services, but the college has now had to be closed owing to the suspension of recruitment as a measure of economy. The first forest school was founded at Dehra Dun in 1878, and the college into which it has now developed, and those more recently established it Pyinmana in Burma and at Coimbatore in Madras, provide the training given to Forest Rangers. Elementary courses are given to selected lower subordinates in most provinces.

The Inspector-General of Forests to the Government of India is adviser in all forest matters, including the management of the forests in the Andaman Islands and Coorg; he tours in any part of India as occasion arises and is also President, Forest Research Institute and Colleges, at Dehra Dun. In the provinces the Chief Conservator of Forests, or a Conservator of Forests, is the highest forest authority and the circle or circles are sub-divided into divisions, ranges and beats. Some 280 Indian Forest Service and 240 Provincial Forest Service officers are now employed and subordinate to them are the Forest Rangers, Deputy Rangers, Foresters and Forest Guards. The duties of this staff comprise exploration of the forest and the demarcation of selected areas, the control of rights and fellings, the construction of roads and buildings, fire and other protection, the re-stocking of areas felled, the disposal of timber and other produce and often its extraction and transport to market. Working plans are prepared for the more important forests, and the main principle underlying them is an indefinitely sustained, or increased supply of the produce in demand. These plans involve a close study of the existing crops and of the conditions under which they have grown, and their prescriptions give effect to the best means by which new crops can be established and grown to maturity. The existing forest is often the very slow outcome of a struggle between various forms of vegetation, not only influenced by natural phenomena, but by fires and fellings and the general treatment to which it has been subject. In consequence conditions favourable for reproduction are difficult to produce and, since many trees only reach maturity in 100 years or more, prolonged attention to the crops is necessary. Silviculture in India has advanced immensely as a result of regulated management and silvicultural research. The production of many varieties of timber has been increased both by improved treatment of the existing forest and by the creation of plantations; some 200 square miles are re-stocked or afforested annually.

The continuous increase of revenue from forests until the world economic crisis

began in 1930 is shown by the following average annual returns of the Forest Department:—

Years.	Average Annual.		
	Revenue.	Expenditure.	Surplus.
	Rs.	Rs.	Rs.
1869—79	61,45,000	42,55,000	18,90,000
1879—89	1,02,43,000	65,18,000	37,24,000
1889—99	1,68,32,000	92,00,000	76,33,000
1899—1909	2,26,81,000	1,26,88,000	99,93,000
1909—19	3,13,68,000	1,87,44,000	1,46,24,000
1919—29	5,75,34,000	3,59,75,000	2,15,59,000
1929—32	4,94,06,000	3,38,72,000	1,55,34,000

These figures take no account of free grants, or of the value of produce sold at concession rates, now estimated at Rs. 66,00,000 per annum; and it has to be remembered that large areas cannot yet be worked at a profit, or will never do more than meet simple local requirements. Approximately 2,000,000 tons of timber and 4,500,000 tons of firewood are extracted annually and minor produce to the value of more than Rs. 1,00,00,000. Apart from constructional work generally, the bulk of the timber is consumed by the railways and mostly in the form of sleepers.

In spite of this large outturn India is on balance a wood importing country as proved by the following figures:—

	Imports 1931-32.	Exports 1931-32.
Teak	Rs. 14·52 lakhs.	Rs. 61·13 lakhs.
Other Woods, excluding Sandalwood and Firewood	Rs. 32·53 ,,	Rs. 2·84 ,,
Wood Pulp	Rs. 35·92 ,,	..
Tea Chests	Rs. 47·48 ,,	..
Manufactures of Wood, excluding Furniture and Cabinetware	Rs. 12·22 ,,	Rs. 9·63 ,,
	Rs. 142·67 lakhs.	Rs. 73·60 lakhs.

Imports of wood by land are not included and they have probably a value of Rs. 30 lakhs even now. The excess of imports was much the same when trade was better; the market for teak is suffering severely with other world markets, but more wood of all classes used to be imported. Certain woods, particularly softwoods, do not grow in sufficient quantities, or their extraction is too costly, to make India entirely self-supporting; at the same time the large variety of indigenous trees denotes possibility

of better utilisation. Some 2,500 species of trees grow in India and it is said that for only 65 timbers does the demand equal the supply ; a market can certainly be created or developed for some of the others.

Problems connected both with the growing of forest and with the utilisation of forest produce were responsible for the inauguration of a centre of research at Dehra Dun in 1906. Until then progress was almost entirely dependent upon the efforts of individual forest officers, and their measure of success was often unknown beyond the division, or beyond the province in which they worked. In 1914 the first Forest Research Institute was opened and within a few years war-demand emphasised scope for research far beyond that for which provision had been made. When systematic forest management was first introduced in India few people believed that it could be remunerative, but in 50 years the surplus of revenue over expenditure had increased ten-fold to nearly Rs. 2 crores, and it was recognised that any further increase must largely depend upon extensive scientific research. So originated plans for the present Forest Research Institute at Dehra Dun which was opened by His Excellency the Viceroy, Lord Irwin, on the 7th November 1929 ; it is the largest institute of its kind in the world. The main building is 350 yards long and covers an area of 7 acres, and in the grounds besides 200 acres of plantation, the arboretum, the fruticetum and experimental gardens, there are separate buildings housing the chemical laboratories, the insectary, the saw mill, the pulp and paper plant and the several wood workshops.

The work of the Forest Research Institute is divided among five branches dealing with silviculture, botany, entomology, economic forestry or utilisation and chemistry. Selected problems for research are prescribed by programme and results are made known to forest officers and to the public in an annual report and periodical publications. Silvicultural research aims not only at speeding up, improving and cheapening production, but in the first instance at maintaining a supply of valuable timbers. It has already been mentioned that reproduction of some of the more important Indian trees is obtained with the greatest difficulty and yet further supplies and revenue depend primarily on success in overcoming this difficulty. Botanical research was one of the earliest activities of forest officers in India ; in the course of exploring the forests, trees and other vegetation were identified, but the needs of to-day far exceed the earliest requirements. Systematic botany no longer merely serves the purpose of an introduction to the flora of an area, authentic identification is as essential to the development of silviculture as to the more extensive use of forest produce. The local distribution of types of vegetation has also been recognised to have great silvicultural significance, and a beginning has been made in the study of damage by fungi to living trees and to felled timber. The entomological branch is concerned with the investigation of damage by insects both in the forest and to forest produce. The extent of such damage is often only realised when forests come under regular treatment, or when the competition of substitutes for forest produce develops. Intensive investigation is being made of certain major pests and control measures are sought which are practicable in application and reasonable in cost. In some cases means of preventing or restricting damage have already been devised and losses which have amounted to lakhs of rupees in a year are avoided. The economic branch

deals with the utilisation of timber and other forest produce ; it comprises separate sections dealing with wood technology, testing, seasoning, preservation, wood workshops, pulp and paper making, and minor forest products. It is concerned with the identification and properties of timbers ; the manufacture of plywood and the general working qualities of Indian woods are put to practical test, and all possible information is collected regarding minor forest products. The high qualities of bamboo paper have already been established and the qualities of many timbers made known. The chemical branch deals with a variety of chemical investigations and analyses ; its main function is research in connection with minor forest products with a view to establishing and developing their use.

It has been estimated that the extraction, conversion and utilisation of timber gives employment to nearly 2,000,000 people in India, and the extraction and preparation of minor forest products must add greatly to the numbers whose livelihood depends on the forests. Many forest occupations are seasonal or cottage industries which enable an agricultural population to supplement their income very considerably ; from this point of view alone forestry is of great economic importance to the country. It is of even greater significance that the forests provide many of the simple needs of a vast number of right-holders, and it is of the greatest importance that forest management should ensure their future supplies. In recent years the practice of raising forest crops with field crops has been extended, so often making a welcome addition to the area available for agriculture ; again less than one-fifth of the government forest is at any one time entirely closed to grazing, and most closures can be so arranged to cause little inconvenience.

The scope for developing forestry and forest industries in India is immense, but the slow growth of trees in itself dictates a steady and far-seeing policy. The complicated problems of forest management require control by men of active habits with the best possible training and assisted by systematic scientific research.

INDIAN FORESTER.

DECEMBER, 1933.

THE ORGANISATION OF FOREST PUBLICITY.

The need for publicity work on behalf of the various activities of government in India is becoming more and more pressing as the responsibilities of government pass from the old autocratic methods to the regime of committees and councils. This is particularly the case in the work of the scientific departments such as agriculture, forests, veterinary and public works, because when those without any scientific training attempt to control or influence the development of such departments and institutions a little knowledge is almost as dangerous as none at all. In the case of forests this is peculiarly so, for only those with a real insight into the science of forestry can appreciate and explain the need for planning generations ahead, instead of merely meeting the need of the hour. A recent issue of *Capital* had some scathing remarks to make about the Canal Department's lack of initiative in producing an out-of-date annual report which gave hardly any popular explanation of the schedules of figures which by themselves mean so little to the "man in the street" but which with a little explanation might serve to awaken popular opinion to the vast scope and importance of the canal officers' work in almost every province of India. From this it will be seen that the public press expects, and has a right to insist upon, a clear but non-technical account of the various scientific activities of government and we as a department should not wait until public opinion forces us to develop this side of our work, but should forestall the inevitable by organising publicity work on a gradually developing scale to meet this need. The day is now past when we as forest officers can afford to plume ourselves on being a "silent service" whose work speaks for itself. Sir Dietrich Brandis with his marvellous foresight realised the need

for placing the work of his very young department before those who then represented public opinion, and he had no hesitation in saying that his Forest Conferences of 1873 and 1875 owed their success as much to their social engagements as to the solid work which was put in at the conference table. The need then was to get conservative administrators to realise that his growing band of forest officers could safely be trusted with the development of the forests. The administration of to-day has altered and our methods naturally must change too, but the need for publicity remains. Our service has been an active and important factor in the development of India's natural resources during the last 70 years, but the average literate tax-payer still knows so little of its activities that we have obviously neglected to follow Sir Dietrich's excellent lead.

The first objection raised to any organised publicity is of course :—"But we have no money to spend on such trimmings," so let us consider just what such a development is going to cost. A careful analysis of the scheme detailed below will show that very little actual expenditure of money is involved though admittedly it entails some extra effort of energy on the part of the existing provincial headquarters staff.

The first step should be to detail an officer in each province who has some facility for writing to take up the preparation of newspaper contributions for the local press as part of his regular routine work. Topical accounts in non-scientific language upon all the usual forest subjects such as forest types, products, markets, roads, working plans, shikar control, grazing problems, erosion, reviews of annual reports and other publications, local developments in plantations and regeneration work, would all be acceptable to the local press, particularly if some working agreement were reached as to the supply of written material. Such work need not necessarily be done entirely by one man, but the responsibility for the arrangements should be definitely allocated and should not be left to the spasmodic journalistic efforts of members of the service acting in a private capacity.

The next step is to develop a local intelligence system by detailing reliable members of the office staff to comb all local newspapers and

particularly the vernacular press in order to bring to notice all references to forest work, and particularly those containing misstatements which ought to be corrected. At present the number of misstatements and ignorant criticisms of government activities in general and the Forest Department in particular which go gaily unchallenged and uncorrected through the vernacular press is truly amazing, and until these criticisms are met and countered with the truth we can hardly blame the average reader for mistaking our present stern and noble restraint for a guilty silence.

A further step would be the preparation of lecture material, particularly of good sets of lantern slides, many of which would only have to be copied from the valuable photographic collections already in the possession of the Forest Research Institute and provincial Silviculturists. These should be prepared in sets of 40 to 60 slides with a *resumé* of lecture notes so that any educated layman could deliver the lecture without much preparation. This line of development has been already demonstrated by the Empire Marketing Board, whose prepared lectures are being very widely used by educationists and welfare societies at home. Such a scheme will also be essential whenever the village radio organisations now being mooted in different parts of India come into being, for we should not miss the very obvious publicity value of the radio.

The publicity officer would also be expected to represent the department in any committee or combined action such as has been so ably outlined by Sir Frederick Sykes for Bombay, because the encouragement of the wood-using cottage industries must obviously form an integral part of any village uplift scheme, and the better utilisation of the local timbers in such work must be in the best interests of both the forest department and of the villagers. Much useful work could also be done by local village uplift movements in demonstrating why wood should be used in preference to cowdung for fuel.

Later will come similar collections of ciné film, preferably of the 16 mm. (Ciné Kodak) size, which is now becoming so widely used in all educational work in Europe and America. It is admittedly an expensive hobby for the individual, but in centres such as the presi-

dency towns and the larger provincial headquarters with several colleges each possessing their own ciné projector, a few well edited films showing forest activities would be of tremendous educational value, and would cost the department very little if the forest officers already using ciné cameras were asked to prepare duplicates of their best jungle films. Ciné films showing Himalayan forest work such as felling, sawing, aerial ropeways, and river floating, interspersed with the more human interests of a forest officer's life on tour have been shown by the writer to several audiences at home and in India such as the Overseas League and Botanical Societies and aroused a very lively interest, so there is good reason for hoping that such films will in time become part of the standard publicity equipment of every provincial forest department.

We now come to the forest education of the younger generation. Leaflets on local tree species and forest types suitable for use in nature study and natural history classes would have a wide appeal amongst teachers, who are only too anxious to secure suitable material for their classes. Simply written pamphlets describing the uses of local timbers, forest plantation and *taungya* work, the advantages of forests to villager, roadside shade trees, the value of fire protection and many similar subjects could be turned out at very little expense. Burma already has a good series of leaflets on timbers and their utilisation, and Bombay recently produced one on *hirda*, but these are for the use of traders and too technical to make much appeal to teachers. *The Forestry Primer* produced by the American Tree Association for use in schools has reached a circulation of over four million copies, which shows what can be done in this direction.

Having produced some ammunition for the battle, our publicity officer must not expect people to flock to him in support. He may not have to seek his helpers in the highways and byways, but he will at least have to get in touch with the Educational Department to find out what are the stages and classes of the schools in which his material may be used, and then to make sure that it is made use of. He will also have to get in touch with newspaper men, who if properly handled would be a tower of strength in furthering publicity for us. They

realise more fully than most people the value of specialised knowledge, and when they see that we as a department really mean to put such special knowledge at their disposal we need fear no difficulty in getting some forest truths placed before a wider public.

To summarise, we would suggest that the head of the forest service in each province, and also the President of the Forest Research Institute should proceed to make definite provision for publicity works along the following lines :—

(1) to detail a member of the present executive staff as publicity officer and to lighten his other routine duties so that this side of his work can be developed ;

(2) to detail members of the headquarters office staff to comb all local newspapers and report misstatements and ignorant criticisms which should be countered with the truth ;

(3) to prepare lantern lecture material which can be used by laymen ;

(4) to take advantage of fresh developments such as radio and village uplift movements to put the forest case before the public ;

(5) to build up gradually a collection of ciné films for use in the larger educational centres ;

(6) to write and distribute pamphlets for use in schools on forest activities and nature study.

THE SALARANG EXPLOITATION.

By Jalmeja Singh, P. F. S., Punjab.

Introduction.—The Salarang Nala, in the Upper Bashahr Forest Division of the Punjab, is 7½ miles long, with a bottle necked mouth and two main branches draining a vast fan-shaped catchment area of

24 square miles in the upper region. For the first two miles it descends from 14,223 feet of elevation to 10,500 feet where it meets the upper limits of the forests, and flows for 1½ miles further with gentle gradients. Thereafter, for 3 miles it consists of large boulders and small cataracts, down to 5,400 feet elevation. Having left the lower limit of the forests 1¼ miles behind at 6,000 feet elevation, it passes through a gorge for one mile with gentle gradients but occasional falls till it meets the Sutlej river at 5,000 feet elevation.

The Scheme.—The scheme of exploiting during two years this inhospitable nala, hitherto considered inaccessible, was taken in hand in 1930. It necessitated the construction of bridges and paths, the supply of rations to labourers, the recruitment of labour and the solving of conversion and extraction difficulties; while the floating condition of the nala had to be carefully estimated. The authorities approved of the scheme but at the same time observed that it was beset with difficulties which lay in the steep and rocky nature of the nala and the forests surrounding it, the treacherous nature of a vast catchment area with a bottle-neck at its bottom end and the lack of suitable housing for the staff.

The Working.—Consequently, a separate exploitation range was created to be run by an E. A. C., Forests, with the assistance of a Forest Ranger and other staff. The extraction being by no means cheap, the forests were marked to their full silvicultural capacity. The sawing work commenced in 1931 in forests standing over the left tributary. Extraction to the stream side by means of coolies and ropeways was resorted to. Telescopic nala floating, aided by wet slides over difficult portions, was commenced on 10th September 1931 and by 5th December 1931, 183,904 cubic feet of sawn timber was stacked in the nala, 1½ furlongs above its confluence with the Sutlej, ready to be launched during the latter half of the following August. It may however be mentioned that owing to some floods during September 1931, an unfortunate omission to build a wet slide in one place, and owing to the brittle nature of wood from old mature trees containing shakes, the timber that reached the depot in 1931 was of poor quality.

The Flood.—During the following August when the sawing, carriage and roping works were in full swing in the other half of the forests, *i.e.*, over the right tributary, a tremendous cloud-burst in the higher parts resulted in a down-rush of water that swept away large trees, huge boulders, the greater portion of the slides and about half of the stacked timber from the Sutlej launching depot and the launching depots along the nala banks. The flood level rose on 12th August 1932 in the bottle-neck 42 feet above the winter water level of the stream. With this unprecedented flood the nala bed sank and the stream changed its course in several places.

River Launching 1932.—The balance of 123,066 cubic feet of timber in the Sutlej depot was launched on 17th August 1932. The nala sides having been recently washed away, and the stacks rendered unstable, launching was difficult and lowering the scantlings by means of rope was mostly resorted to.

Nala Floating 1932.—After this catastrophe it was apprehended that owing to the lack of slides the date of floating operations might have to be considerably postponed, but after a thorough reconnoitring of the nala, and taking into consideration the labour conditions, the date was postponed to 1st October 1932, *i.e.*, by 20 days only. The autumn nala floating usually commences on 10th September. 4,247 feet of slide were built by two parties in 63 days (from 13th September 1932 to 16th November 1932), a good portion of the slide resting on stanchions stuck into the vertical rock. The *muhri* of the *ghal* arrived below the last slide on 19th November 1932, before which the timber had to be roped over a huge slip, as well as over a waterfall nearly 80 feet in height. Construction of deep pools was resorted to ; in fact in one place the water level was raised by 14 feet to prevent the sleepers striking the bottom. Owing to experiences gained during the 1931 floating work, the 130,082 feet cubic timber stacked in the Sutlej depot by 20th December 1932 was in good condition.

Experiences gained.

(*i*) *Timber damage.*—Most of the damage to timber is caused during launching; and, while in transit, in the pools; and in the main river by contact with projecting stones, or with other scantlings, either in floods, or when the water is very low. The damage in the former case can be minimized by avoiding stones in the pools during launching or covering with grass the projecting stones against which the scantlings strike; placing the mouth of telescopic slides as near the water as possible; resorting to deep pools; permitting the scantlings to glide down the telescopic chutes and wet slides one by one and at regular intervals; constructing wet slides in short sections even in places where the nala is apt to cause damage; packing the joints of the slide every morning with moss; and erecting ropeways wherever feasible at a reasonable cost. Needless to say, the floating operations in these nalas should commence when the danger of autumn floods is completely over. The timber in the river is at the mercy of the current. Too much water is better than too little, if the timber is to pass over big boulders. The coniferous species arranged according to their brittleness are deodar, kail, chil and silver fir.

(*ii*) *Depot site and launching.*—When selecting the site of a launching depot, it is imperative that the method of launching is kept in view. The site must invariably be much above the flood level, especially in the bottle-necks. An ideal place is where the timber would slide at an easy angle into the water direct. Dry places and places near nalas with very scanty water should be avoided as far as possible. On flat places, the site should be near to the brink, provided the latter is not unstable. The selection of good sites, arranging timber in lots of 100 or 200, and locating stacks in a systematic manner are each important.

In the steep hills of Kanawar, the choice is often very limited by the cramped space available; for instance in the Sutlej depot the stacks resting against the hillside contained 1,000 scantlings, while on level bits the vertical stacks contained 600 scantlings. Consequently the following modes of launching were adopted in the

Salarang depots :—

	Position of the stack.	*Mode of launching scantlings.*
1.	On a very high bank, and the stack vertical.	Lowering one by one by means of a rope tied to the hind end, into the chute or water, or on to the ground below.
2.	On a high bank, and the stack resting against hillside.	By sliding down the stack one by one with speed controlled by means of a rope tied to the hind end, till it reaches the ground or chute below.
3.	On steep or moderately steep bank with no stones projecting.	By sliding, the bank serving as an earth slide with the speed controlled by means of a rope, which can however be dispensed with in less steep banks.
4.	On steep or moderately steep banks with stones projecting or with boulders below.	By sliding in telescopic slides kept moist by sprinkling water.
5.	On gentle slopes with no stones projecting.	By pushing along wooden rails built of scantlings till the water is reached.
6.	On gentle slopes with stones projecting.	By pushing end on in a trough built on a frame work of scantlings.
7.	On level ground	By lifting and carrying to water.

SCOTTISH FORESTRY SOCIETY'S CRUISE.

The excursion this year consisted of a cruise for a week on the West Coast of Argyll, Inverness, and Ross, with landings each day at places of forestry or other interest. Although the excursion covered

a considerable stretch of the West Coast, some 150 miles in a direct line from Loch Broom in Ross to Loch Fyne is Argyll, there is little variation in two factors of great importance in tree growth, *viz.*, temperature and rainfall, both of which are relatively high. On the other hand, two other very important growth factors vary very much, and these are the soils and the amount of exposure to wind. The geological structure of the West Coast is very complicated, and many different kinds of rock occur, producing very different classes of soil. The very much indented coast line is responsible for the great changes in exposure which are found. Where a good soil occurs in a sheltered position very remarkable results can be achieved. In other cases, where the soil is reasonably good but shelter lacking, some very wonderful successes have been obtained by planting storm-resisting trees to afford shelter to less hardy plants. Two instances were seen —at Arduaine in Argyll, and Inverewe in Ross,—where situations formerly wind-swept and almost devoid of any vegetation have, by planting shelter belts of trees, been turned into gardens in which many half-hardy shrubs grow in the open all the year round which cannot be grown outside in many parts of England.

Another item of interest demonstrated is the superior growth on the West Coast of many of the more recently introduced conifers from North-West America over Scots pine and the older exotics. Some unusual species can be seen growing under forest conditions and apparently promising well, *e.g.*, several species of *Eucalyptus* at Kinlochhourn in Inverness, and *Cupressus macrocarpa* at Arduaine. One or two remnants of old natural Scots pine were visited, and it was interesting to see how they compare with younger woods of the species which generally are not thriving. The late Mr. Osgood Mackenzie of Inverewe, who laid out the gardens there which were also visited, states very emphatically in his book, "A Hundred Years in the Highlands," that the failure of the younger Scots pines was due to the fact that they were reared from imported seed, and were unsuited to the locality, whereas the old native stock has been thoroughly acclimatised. This illustrates very forcibly the importance of securing proper seed.

SYNOPSIS OF DEODAR NURSERIES IN KASHMIR.

By H. S. JAMWALL, M.F., KASHMIR FOREST SERVICE.

1. With the introduction of the shelterwood system in practically all the rich conifer forests of Kashmir, the maintenance of small nurseries in Periodic Block I areas has of late become an obvious necessity of forest management. It has now been fully realised by all the officers concerned that the raising of stout and sturdy planting stock is absolutely essential to fill in such blanks as have been left unregenerated naturally. Moreover, the last seven years' practical experience has conclusively proved here that natural regeneration of deodar in felled areas, under this or any other system, is never quite complete and that some measures have to be adopted to regenerate artificially those failed places that nature refused to fill in satisfactorily.

It is therefore obvious that the forest officers engaged in this regeneration work can under no circumstances whatsoever dispense with nursery work, however favourable the locality and other allied factors may be in their forests.

2. It was in the Langet division that the shelterwood system was first introduced in the history of forest management in Kashmir in Sambat 1981 (1924-25), and it has now no less than 30 compartments under regeneration in four ranges. The area under both the Langet and Lolab Working Plans comprises about 7,213 acres of forests so far brought under Periodic Block I. Though, thanks to the careful selection of Periodic Block I areas by the Working Plan Officers, most of them had very good advance growth already established, yet quite a few are patchy, or are absolutely devoid of any regeneration whatsoever, as for instance Compartments 25, 27, 13 and 14 in Lolab and 35*a* ***kail*** coupe in Mawar Range.

3. In order to meet the great need of keeping regeneration abreast with fellings extended over this vast area, and to catch up the arrears of the last six years, the writer laid down no less than seven temporary nurseries in the division. The Lolab itself had four nurseries excluding one *taungya-cum*-nursery plot in Compartment 119. The total number of seedlings raised in these nurseries was about 300,000.

excluding the magnificent stock of seedlings reared in ash beds which latter contain probably another 200,000 seedlings. Most of the stock being now two years old, has been planted out this spring to fill in many blanks in the forests.

4. The condition of nurseries in this division can well be visualised from the following remarks of the Chief Conservator of Forests who inspected them last year :—

"Regeneration work in Compartment 11 (Ramahall) is also eminently successful. In fact regeneration work throughout these forests has reached a very high standard. Nurseries are well kept and are a model of what nurseries should be, closures are effective and all regeneration areas bear the mark of careful management."

5. Just as the success of broadcast sowing depends mainly on the quality of the seed used, so are planting operations governed by the quality of stock available for artificial regeneration. The natural inference, therefore, is that only strong and healthy plants that have fully developed their lateral roots, and whose shoots have a dark green appearance must be used. Consequently to obtain such stock the maintenance of small and temporary home nurseries is a foregone conclusion.

6. It must, however, be borne in mind that the framing of small home nurseries in any forest in Kashmir is not so difficult as some appear to believe and that success in this operation can be obtained, provided the following cardinal points are kept in view at each stage of nursery work :—

a. Site.—A good nursery site is essential and should invariably be selected by the D. F. O. himself or by an experienced and reliable trained ranger, for often an initial mistake made in selection of site can never be corrected. The site so chosen should necessarily be given to a farmer to raise one or two crops on as this will improve its texture considerably. As far as possible water facilities should always be taken into consideration, although in a place like Kashmir it is hardly required for more than two months. The site should not be open from all sides and may preferably be so located that it enjoys afternoon

shade from the surrounding forest. Where frost is badly feared it should be located in the midst of a stand not unlike the beach nurseries often laid out under a canopy of fir in Germany.

Northern and north-western aspects for nursery sites are generally advocated by most forest officers, yet experience here has shown that in Kashmir like all other temperate regions one can easily raise conifers on almost any aspect provided the minute details of work are attended to ungrudgingly. A small deodar nursery, was laid out on the barren southern slopes of Compartment 50, Darapura, in Lolab, which is probably the hottest spot in the whole valley, without unusually heavy expenditure. Here, of course, nursery beds had to be shaded from the intense direct rays of the afternoon sun, and for this purpose a simple device of planting willow cuttings around the beds and tying their heads together across the beds, was followed and numerous branches put forth by these cuttings in the spring offered excellent shade all summer.

b. Seed.—Only seed of good quality should be used and it should be sown fairly thick after the soil is thoroughly pulverised and mixed with well decomposed humus, preferably leaf mould. The best criterion for good and fresh deodar seed is that it must be yellowish brown in appearance and the embryo inside must be quite sticky, soft and deep green in colour, while the old seed (*i.e.*, more than a year old) is always shrivelled and is deep brown in colour while the embryo inside is invariably stiff and dried up and light green in colour. The seed should be sown either in late autumn or early spring. Good results have also been achieved by sowing seed in nursery beds covered with a foot of snow in February.

c. Manuring.—Many workers have advocated quite a number of different kinds of both natural and artificial manures and fertilizers for nursery work and one may find a long list of these in an elaborate article on the subject by Mr. P. N. Deogan, in the May *Indian Forester*. However, one questions the desirability of these expensive manures for conifer nurseries in far off places in these days of acute financial stringency and one cannot but see eye to eye with Mr. Champion who has sounded a timely note of warning in the *Indian Forester* of

last April. He says : "We foresters not unlike engineers may sometimes be open to the same charge in some of our plantation work when we carry it out under the most favourable conditions with all the elaboration essential in unfavourable localities." The writer, always keeping in view the lowest possible cost of operation in forest works, therefore makes bold to state that he had been raising small nurseries in Langet division for the last five years, and had never spent a farthing on the purchase of any fertilizer, yet seedlings raised are so beautiful, strong and healthy that most of them measured about 30 inches in two years, probably better stock than could be produced by using any artificial manure.

The most favourite and useful manure commonly used in this region is a well decomposed humus which is always available from underneath the old deodar and *kail* trees in the forest. The seed sown in beds is invariably covered with this manure and when germination is over and seedlings have established themselves, two to three applications of ash manure are given during the season. This ash manure is formed by burning huge piles of dry deodar and *kail* needles always at hand in the forest, and stored up in one corner of the nursery. The ash manure is also always procurable from the *zamindars* who use it extensively in their paddy fields. This manure has always given excellent results when used in nursery beds. In fact, seedlings turning pale either for physiological or physical want of nutrient, will at once recover with one or two applications of ash manure after watering the nursery. In this matter one may as well take one's cue from the healthy deodar seedlings so often found in a severely burnt forest tract.

d. Weeding.—This is very essential and is too tedious for one man to look after in a nursery larger than $\frac{1}{4}$ of an acre.

However, when the nursery is more than an acre and present financial conditions do not permit of employing more than one man, it is advisable that the forest ranger in charge of work should call all his forest guards and foresters and disburse their pay in camp or from the nearest forest rest-house and take one full day's work from all of them. This gets the nursery weeded thoroughly as is being done now in the Southern Lolab range.

e. *Pricking out.*—This operation is a bit expensive and need not be done where cost is prohibitive. However when pricking out in the nursery beds is to be avoided and seedlings are planted direct in the forest, the seed must be sown in lines in beds, for it is much easier to lift seedlings afterwards from these lines than from broadcast sowings. Where the seedlings spring up too dense in nursery beds, it is advisable to thin them out *in situ*, but care must be exercised in doing this, because by pulling out the weaklings healthy ones are often injured. It is therefore better to cut the weaklings with scissors rather than pull them up.

f. Damage.—Although much has been written about the immense damage done in nurseries by rodents and other birds and insects, yet the fact remains that heavy damage through these agencies is not frequent in this part of the country. However, some damage has been observed in nurseries in the Lolab through the following agencies :—

(*i*) *Birds.*—A bird whitish blue in colour locally called *pinchikani* in Kashmir does a lot of damage. The writer has observed a flock of these birds over nursery beds nipping the delicate cotyledons of deodar seedlings that are only a few days old. They cut the stems then fly back to the surrounding trees in the forest to devour them.

The damage can be controlled by frightening the birds with scarecrows erected on the beds. If beds are badly eaten it is better to resow them, and this is successful because the damage is done so early in spring that still enough time is left for resowing the nursery.

(*ii*) *Rodents.*—Often quite a large number of seedlings have been found cut underground by rats. The seedlings look healthy outwardly but when dug out one sees tap roots cut clean through. Last year hundreds of two-year old seedlings were seen cut by rats in Chandigam nursery.

The cheapest and easiest method of control is by smoking the rat holes as described in the August *Indian Forester*, and can be done without any risk or expense.

A PRELIMINARY NOTE ON THE LEAF-CURL MOSAIC DISEASE OF SANDAL.

BY M. G. VENKATA RAO, B.A., ASSISTANT CONSERVATOR OF FORESTS, BANGALORE.

Introduction.—It is well known that sandal, *Santalum album* L., in southern India is affected by a serious disease known as "Sandal Spike." Coleman (3) established its highly infectious nature, and suggested that it was a virus disease, and further confirmatory evidence in support of this view was obtained by Narasimhan (4) who found intra-cellular bodies in spiked leaves similar to those found to some other plants affected with virus disease.

It has not been known up till now that sandal is subject to any infectious disease other than sandal spike. Non-infectious chlorosis, often with marginal variegation, is sometimes seen on sandal trees, especially in dry localities. Recently, the writer found a large patch of jungle well stocked with sandal trees in Jakkur plantation, Bangalore district, severely affected by a leaf-curling mosaic disease to be described in this paper. The infected area is approximately 20 acres and an enumeration of sandal in the locality showed 53 healthy trees and 138 affected by the disease, two trees among the latter being found dead. The same disease has been found in two trees in Bangalore city, two in Mysore city and in one tree in Jalhalli plantation. A search may reveal more trees in other localities. Its appearance in areas far removed from each other must be viewed with considerable anxiety, as its potentialities for spread and destruction are at present unknown.

There are several cases reported where the same plant is subject to more than one virus disease. Smith (6) has described two diseases of the peach tree, peach yellows and peach rosette, the latter bearing a strong resemblance to the spike disease of sandal. A third disease of peach known as little peach is described by Blake Maurice (2). Schultz and Folsom and many others (5) have distinguished and transmitted several degeneration diseases of potatoes designated as mild mosaic, leaf rolling mosaic, rugose mosaic, streak, leaf-roll, spindling

tuber disease and unmottled curly dwarf. The object of this paper is to describe a new infectious disease of sandal recently found, which I propose to call 'Leaf-curl Mosaic' disease of sandal.

Description of the 'Leaf-curl Mosaic' Disease of Sandal.—In the field two stages of the disease are clearly discernible. In the first stage (Plate 36, Fig. 1) conspicuous mosaic spots develop between the veins of the leaves (Plate 37, Fig. 4) which are characterised by slight rolling. Young leaves produced at tips do not generally show the mottling, but it appears as the leaves attain their full size (Plate 37, Fig. 4). In some of the pigmented types of sandal, a reddish brown discolouration is seen at the edges of leaves. The leaves retain their normal size, and the tree bears flowers and fruits as usual. Branchlets and leaves generally show a marked drooping habit. The trees appear to remain in this stage during one growing season.

In the second stage (Plate 37, Figs. 2 and 3) the new leaves produced show ruffling at the edges even when they are quite young, developing a wrinkled and mottled appearance as the leaves grow old. Some of them become cup-shaped. Dwarfing of leaves and leaf-bearing twigs becomes conspicuous, and new leaves that develop become progressively smaller in size, and finally get curled down the midrib. The lower leaves in the shoots generally curve inward while those at the tip bend outward. The colour of the leaves is green to pale green, turning greenish yellow towards maturity. In some trees, the leaves develop a reddish brown discolouration on the margin and in patches on the leaf blade. The reduction in leaf blade, unlike that in spike disease, is generally greater in length than breadth, and sometimes more or less uniform both ways. The length of the internodes and petioles, however, is not appreciably reduced, though there is a considerable reduction in thickness (Plate 37, Figs. 2 and 3). The leaves lose their flexibility, become thickened and brittle and fall off prematurely. Twigs and branchlets start dying, and adventitious shoots appear on the stem, sometimes in clusters. In twigs and branchlets, there is often an appreciable thickening of the nodes, as dormant buds open out and die and new buds are formed in their place. In summer months the leaves produced from adventitious shoots in

some cases get attenuated to little more than mere midribs. These leaves fall off quickly leaving thin leafless green shoots. Excepting in such extremely attenuated shoots, the diseased trees produce normal flowers, but the fruits formed are ill-developed and fall off prematurely. The period the sandal survives after the appearance of the disease is not yet known.

Transmission of the disease by grafting.—To ascertain if the disease is infectious, two five-year old sandal trees raised from seeds collected from a tree in Shimoga were selected for inoculation in the Central Nursery, Bangalore, which is nearly six miles from Jakkur, the infected locality. They are nearly 20 feet high and growing very vigorously with large dark-green leaves.

Each tree was inoculated with six ring-bark-grafts on different twigs among the lower branches. The technique adopted for ring-bark-grafting is as follows:—The twigs of the tree to be inoculated are girdled by removing the bark all round to a width of about an inch, and substituted with the bark of an infected twig of corresponding dimensions and bandaged. The material for grafting was selected from two trees in the second stage of the disease in Jakkur plantation. Twenty-five days after inoculation, the new leaves produced in some of the upper branches and top of the tree, showed distinct ruffling at the margin which rapidly became conspicuous. Nearly two weeks later, these leaves became severely wrinkled (Plate 37, Figs. 8 and 9). Six weeks after inoculation nearly half the number of branches in the trees were affected, and an adventitious shoot from one of the lower branches had developed small curled leaves. At first mottling in the new wrinkled leaves was not evident, but developed slowly later on, two months after inoculation. The original leaves existing on the trees before inoculation remained unaffected and the symptoms of the disease were only seen on the new leaves produced.

It is also interesting to note that the disease did not necessarily first appear on the inoculated branches but rather on those growing most vigorously. In the experiment conducted the inoculation was done only on the lower branches, where the vegetative growth was naturally poor. The disease appeared on only two of the twelve

inoculated branches, while at about the same time leaves showing the disease symptoms appeared on the middle and upper branches of the trees. It seems certain that, unlike the sandal spike, the leaf-curl mosaic spreads very rapidly to different parts of the infected tree.

A comparison of the Leaf-curl Mosaic with Spike Disease of Sandal.—From the description of the Leaf-curl Mosaic given above, it is seen that this disease differs in certain marked respects from the spike disease of sandal. Among the external symptoms of the two diseases of sandal, the points of similarity are :—

(1) Severe dwarfing of the leaf blade, the extent to which it is reduced being approximately the same in the two diseases.
(2) As the diseases advance, new leaves produced become smaller and smaller.
(3) Loss of flexibility and development of brittleness of leaves.
(4) Development of adventitious shoots.
(5) Premature death.

The differences in symptoms between the two diseases ascertained so far are tabulated below :—

Symptoms.	Spike disease of sandal.	Leaf-curl mosaic disease of sandal.
1. Reduction in leaf blade.	Severe reduction in size when the disease first appears. Reduction always greater in breadth than in length.	Reduction is gradual. It is generally more in length than in breadth, but sometimes uniform in both directions.
2. Texture and shape of leaf blade.	Stiff and erect ..	Wrinkled and curved.
3. Colour of leaf blade	Pale-green to yellow ..	Green to pale-green.
4. Mottling of leaves	Absent	Not generally seen in young leaves, but conspicuous in full grown leaves.
5. Petiole ..	Dwarfed in proportion to the leaf blade.	Nearly the normal length of petiole is retained.
6. Internodes ..	Considerably shortened ..	Length of internodes generally normal.
7. Flowers and fruits	Fully infected branches bear no flowers.	Infected twigs produce both flowers and fruits.
8. Incubation period	Shortest incubation period $2\frac{1}{2}$ to 3 months.	The incubation period in the experiment conducted is 25 days.
9. Spread of infection to different parts of the tree from the point of inoculation.	Slow	Very rapid.

The leaf-curl mosaic disease of sandal has a greater resemblance to some of the mosaic diseases in the *Solanaceae* than to sandal spike. Allard (1) gives the following symptoms for tobacco mosaic :—mottling, chlorosis, dwarfing, blistering, distortion of blossoms, bleached corollas and mosaic sucker growths. The resemblance is more striking to some of the mosaic diseases of potatoes, especially to the rugose mosaic distinguished by Schultz and Folsom (5) as having a symptom complex consisting of distinct dwarfing, chlorosis, diffused mottling, rugose type of wrinkling and a tendency to show brittleness, spotting, streaking, leaf dropping and premature death. Most of these symptoms are also common in leaf-curl mosaic of sandal, and even the rugose type of wrinkling is seen on many leaves especially in the later stages of the disease.

A detailed study of the disease has been undertaken and a large number of experiments started which will form the subject of a further paper.

Summary.

A new infectious disease of sandal, designated as 'Leaf-curl Mosaic' is described.

The symptoms complex of the disease consist of dwarfing of leaves, mottling, ruffling, wrinkling, curling, brittleness, leaf-dropping and premature death.

The disease was communicated to two healthy trees by inoculations with bark grafts, and the incubation period was about 25 days. The spread of infection to different parts of the inoculated trees was very rapid.

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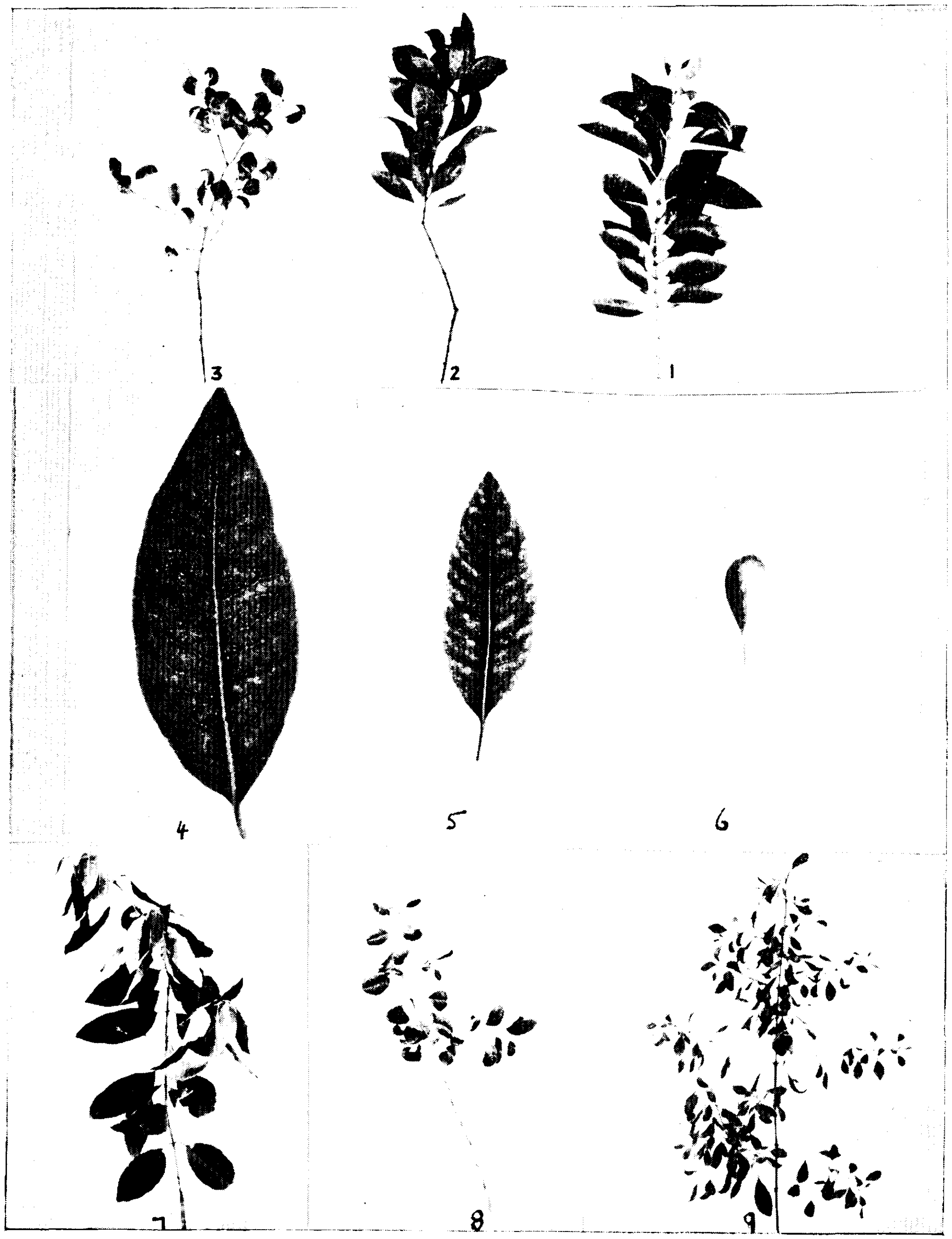
M. G. Venkata Rao : Mosaic Disease of Sandal.



M. G. Venkata Rao : Mosaic Disease of Sandal.

Details of Plates.

Plate 36:—

Figure 1. General view of the first stage of the disease. The leaves are of normal size, mottled, slightly folding and dropping.

Figure 2. General view of the second stage with dwarfed, wrinkled and curled leaves.

Figure 3. An advanced stage of the disease with several dead branches.

Plate 37:—

Figure 1. A twig in the first stage of the disease where there is no dwarfing and the conspicuous symptom is mottling.

Figure 2. A twig in the second stage of the disease with wrinkled, dwarfed and mottled leaves.

Figure 3. An advanced stage with considerably dwarfed and curled leaves.

Figure 4. A leaf from a sandal tree in the first stage of the disease showing slight mottling.

Figure 5. A leaf from a sandal tree in the second stage of the disease with pronounced mottling.

Figure 6. A leaf in the advanced stage of the disease, considerably dwarfed and curled.

Figure 7. An uninfected twig of one of the inoculated trees in Central Nursery, Bangalore.

Figures 8 & 9. Two infected twigs from the two trees inoculated, two months after inoculation.

THE MEANING OF CROP DIAMETER AND THE USE OF THE ALIGNMENT CHART.

BY H. G. CHAMPION, SILVICULTURIST, F. R. I.

It is surprising how persistently the meaning of the term *crop diameter* as given in yield tables is misunderstood, and consequently how frequently faulty deductions are made from the figures given in the tables. There is also a great deal of loose writing in our working plans about fixing the rotation as the time required to produce trees of a certain girth or diameter, either by taking the number of years from ring counts of large trees, ignoring the plain indications in the

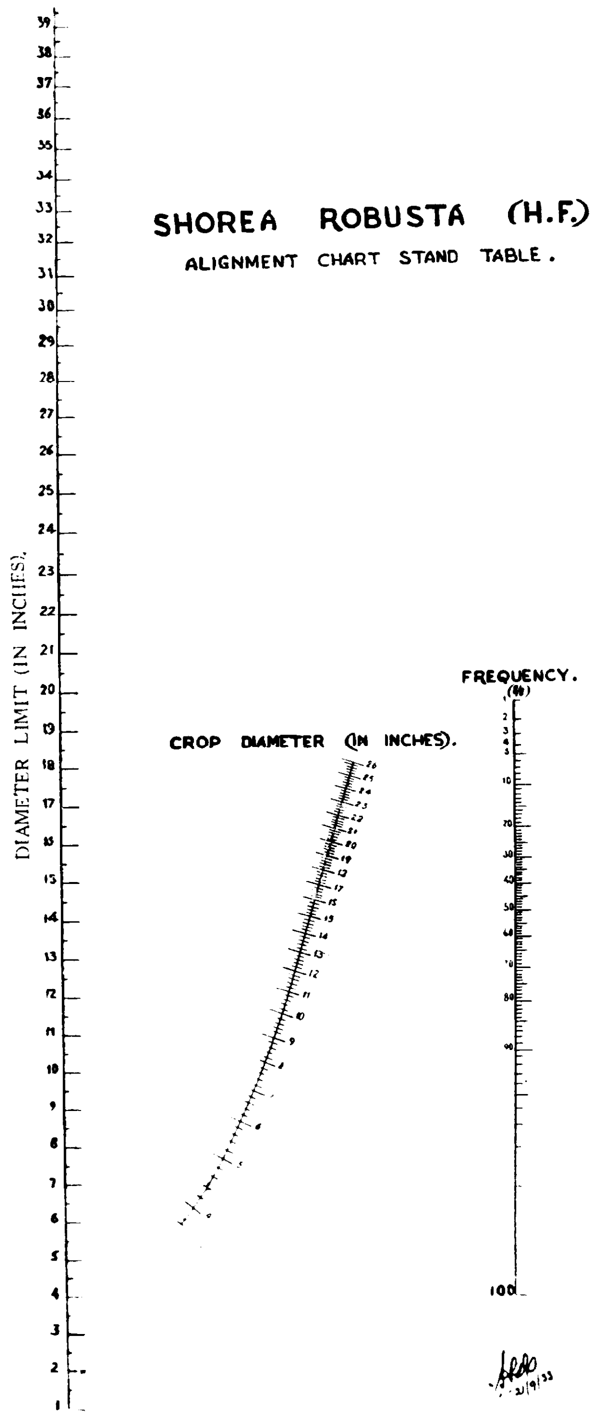
tables that the vast majority of trees in the forest can never reach such a size but must die or be removed earlier ; or equally mistakenly, taking it directly from the yield tables without due consideration of the fact that the only diameters given are crop averages, neither more or less. By those constantly working with sample plots and crop data, the crop diameter is viewed as a purely mathematical conception, and the crop is visualised as consisting of stems of a wide range of diameters from about one half to about twice the average figure, and conversely it is kept in mind that the diameter increment of trees of a given size may be very different from that of a crop of the same crop diameter.

How many of us could say what proportion of the crop, or how many trees per acre if fully stocked, are over 6′ girth, (22·5″ diameter for *sal*) in the 100 year old crops of II and I quality of the *sal* yield tables with crop dimeters of 18·1″ and 21·6″ respectively ? The answer ought really to be given at the end of this note but we will resist that temptation and note that on available data, it would be 7½ per cent and 30 per cent or 5 and 17 trees per acre.

The point turns up most frequently in connection with deciding on rotation under the regular system where trees of a certain minimum girth or diameter are required, but it has appeared again in connection with attempts to derive some indication from yield tables as to what to expect under selection working, attempts justifiable in the complete absence of statistical growth data collected in and for uneven-aged forests.

Our older yield tables and almost all the European tables do not give any figures showing the average distribution by diameter classes of the trees in a crop of a given crop diameter, though the Scandinavian countries have collected a lot of data on the subject and stressed the value of this information. The yield tables for blue pine published in 1929 included a ' stand table ' shewing the percentage of stems exceeding given diameter limits in 1″ steps, in crops of diameters from 2″ to 24″. The multiple yield tables for deodar just out of the press likewise include such a stand table though it is somewhat differently computed and tabulated. Similar tables are also in the press for *sal*

Plate No 38.


SHOREA ROBUSTA (H.F.)
ALIGNMENT CHART STAND TABLE.
DIAMETER LIMIT (IN INCHES).
CROP DIAMETER (IN INCHES).
FREQUENCY.
100

as a supplement to the published yield tables, with some degree of extrapolation of the basic curves to cover higher ages and crop diameters; and tables are also given in the usual 4″ diameter classes both down to zero and to the customary 8″ lower enumeration limit, for convenience in comparison with enumeration data. It is hoped before long to publish similar tables for the remaining species for which we have yield tables, as the data are already available from the sample plots. Of course, all the figures are only rough averages unlikely to agree closely with any individual plot.

Now such tabular statements are generally inconvenient in use in that they only give figures corresponding to exact whole inches of diameter, whereas concrete examples (as for example the crop diameters at whole decades of age given in the yield tables) usually call for values corresponding to intermediate decimal values. Approximate interpolation is of course good enough in most cases, but if greater precision is required, as when the figures are to be the starting point for further calculations or comparisons, one is often constrained to reconstruct the basic curve and read the required values from it—which makes demands on time and facilities. The basic curves could not be reproduced on a scale large enough for practical use or this would have been done, but it is thought that it might be of some interest to give a typical reproduction here to illustrate the alignment chart method which has been found so convenient in this work (Plate 38).

The alignment chart method for the compilation of stand tables is briefly described in Appendix II to the deodar yield tables and the detailed steps need not be mentioned here. Actually the method is a general one applicable to all problems dealing with similarly variable quantities and was found by trial to be the most suitable method available for this particular problem. It will be noted that the left hand axis is uniformly graduated throughout for diameter limit whilst the right hand one is a special decreasing scale representing the percentage frequency with which diameters occur up to a selected diameter limit. This right hand scale looks difficult, but actually is

very simply derived from a temporary uniform scale representing crop diameter, by substituting* for diameter the percentage frequency derived from all the field data combined together on the permissible assumption that the frequency curve is of the same general form throughout.

The use of the chart is best illustrated by an example. In a crop of 18·1″ crop diamter (Quality Class II, age 100 years), what percentage of the total number of trees will be above 5 feet girth ? Five feet corresponds to 19·1″ on a circular section or 18·7″ with the special *sal* factor (0·3119). The straight line from 18·7″ on the left axis, through 18·1″ on the central curve cuts the right axis at 68 per cent. and the answer required is 100 – 68=32. Using the tables, a double interpolation is called for, so that direct use of the chart is much quicker and more convenient, though obviously it must be on an appreciably larger scale than this reduced reproduction.

The compilation of these stand tables and the differentiation of our regular crop yield tables by thinning grades probably completes the growth statistics required for even-aged crops, though of course all our tables so far must be viewed as rough first approximations to be revised and improved as more data accumulate through remeasurement of our existing plots and the gradual filling in of present gaps in the series. This realisation must lead to renewed reflection on the extraordinary and hardly excusable lack of comparable data for uneven-aged forests. It is very evident that our energies ought now more than ever to be directed towards building up a comparable body of information for the very extensive areas of forest still uneven-aged and apparently likely to remain so for a very long time if not permanently.

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* This substitution is done for the average diameter corresponding to each step of 10 in percentage frequency and the scale then completed and regularised. Next, for any crop diameter, say 16·5″, the 50 per cent frequency on the right hand axis is joined to the diameter limit, say 14·9″, which on the averaged and smoothed field data for the 16″—17″ crop diameter class, includes 50 per cent of the crop; similarly for 60 per cent, 40 per cent, etc. Ideally all these lines should intersect in a single point which provides one point on the central curve of Plate 38. The same steps as followed for other crop diameters giving further points through which ultimately a curve is drawn, and the graduation regularised with the end result shown in Plate 38.

TRONÇAIS WORKING PLAN REVISION.

BY R. M. GORRIE, D.SC., I.F.S.

Many of the officers now serving in the I. F. S. will have varied, but on the whole pleasant, recollections of a sojourn in the forest of Tronçais, though possibly the memory lingers more fondly over glorious bathes in l'Etang de St. Bonnet and rugger scrums in the local *estaminet* rather than upon the enthusiasm of our revered instructors for its magnificent oaks! A note on its recent silvicultural progress in *la Revue des Eaux et Forêts* from the pen of M. Paul Buffault has served to refresh the memory and bring our information up to date. There is much in the history of Tronçais which finds a close parallel in our Indian forests, and in particular their method of dealing with a very serious shortage of middle aged-woods.

The forest of Tronçais is the remains of an immense primeval forest which in former days covered the whole of the north-west portion of the central plateau between the Allier and the Cher rivers. Its original area was estimated as being at least 18,000 hectares, but to-day it covers 10,435 hectares (25,785 acres), and thus constitutes the seventh largest forest in France. It occupies an undulating plain which separates the Bourbonnais and the Berry districts, and is divided into three distinct masses by the Marmande and Sologne streams, both of which run north-eastwards to join the Cher. The altitude varies from 375 metres to 224 metres above sea level, the average being about 260. It is surrounded by agricultural communes amongst whose wheat fields and pastures are many small blocks of coppice which must originally have formed part of the forest. These communes all claim certain rights to firewood, cattle grazing and the pannage of swine, but they also provide a ready market for the smaller forest produce and solve the problem of housing the small army of wood-cutters, stave-cutters, timber carters, and sawmill hands, whose livelihood depends on the outer world's appreciation of Tronçais oak for furniture and brandy casks.

Tronçais has had a reputation for the quality and size of its oak timber since first the Romans came to Gaul, and the mere quotation of the cubic contents per tree would give little impression of the

grandeur of the old oak stands. There still remain some 600 hectares of Colbert's Reserve in the central portion of the forest, between the Sologne and the Orleans-Moulins high road and in many of these compartments the trees of 240 to 270 years of age are still growing vigorously and their timber is absolutely sound. They constitute a proof of "what might have been" if the whole forest had been treated similarly to the Reserve, and, to take a more optimistic view, a proof of what can almost certainly be accomplished now that the wise and conservative methods of M. Raffignon have been officially confirmed in the 1928 prescriptions.

Early History.—The forest was of supreme importance alike to the Roman legions and the barbarian tribes as a stronghold, and also, as trade developed under improved conditions, as a source of wine casks which replaced the leather bottles of the Romans, and of fuel for the iron industry which Cæsar established. According to ancient traditions Tronçais was originally owned by a dozen communes, but as the cost of guarding it absorbed and exceeded the revenue, the communes abandoned the ownership to the Dukes of Bourbon. Thus since the thirteenth century it has been owned by the Bourbons as a private right, and maintained and regulated by them for the communes, in so far as they found such maintenance compatible with the prior claims of hunting.

Considerable inroads by cutting were made by monks and communes alike. In 1271 Agnes de Bourbon gave leases of grazing rights to any who would settle in the district, with the effect that grazing was so common that the quality of the woods deteriorated. The woods were used as a shelter by many lawless characters such as the refugees after the Pastoureau rebellions of the thirteenth century. The customs of those times can be gauged by the story of the squire of Maziéres who laid hands on every monk he could, planted them in his courtyard up to the armpits in the ground, and then proceeded to bowl boxwood balls at them as a new form of skittles! The forest remained the property of the Bourbon family until the Treason of Bourbon in 1527, when it was confiscated by the Crown, and from that date it has remained in the possession of the state.

The 1670 Working Plan.—The long continued maltreatment of Tronçais was brought to a stop with the rise to power of Colbert, whose far-sighted policy did so much to establish method and good management in the French forests. The Commission appointed by him in 1670 made a very adverse report and pointed out the great damage already done by encroachments, fellings, overcrowding of grazing areas, and the burning of the woods to secure better pasture. At this time the forest contained the following:—150 hectares of planted young oak, 830 hectares of old oak, thin and in a decline, and 8,170 hectares ruined by fellings, which had left only a few poor oaks and heather, with all young growth browsed down.

The 1670 Working Plan laid down a conservative cut of 25 hectares per year amongst the remaining old oak for naval requirements, and a planting scheme for restocking the destroyed areas at the rate of 100 hectares per year, reserving wherever possible 10 stems per hectare of the old standards. This plan aimed at establishing a rotation of 200 years, and its prescriptions were carried out with great care until 1736, then with less precision until 1779. It is entirely due to this re-establishment of the forest that the present fine stands of Plantonnée, Morat and Pelloterie are in existence to-day, and the delimitation of the Tronçais boundaries by the Colbert Commission undoubtedly checked the ravages which would otherwise have brought about the total extinction of this forest area.

Effects of Iron Industry.—During the last third of the eighteenth century the iron industry developed enormously and the forges established in connection with the Berry mineral deposits consumed great quantities of wood as fuel. Having exhausted the Berry forests the ironworkers next demanded supplies from Tronçais. In 1788 a concession was obtained to establish forges near St. Bonnet village and at Sologne. These formed the nucleus for the industry which is still in operation to-day in the Tronçais wireworks, under the management of M. Moulle, and which has supplied the steel cables for the Eiffel Tower and the sounding cables of many of the oceanographic expeditions and surveys.

The restrictions put upon the communal rights of pannage, grazing, and fuel gathering by the Colbert Commission fell into neglect during the close of the eighteenth century, when the administration of the last few years of the Monarchy and the first of the Revolution was marked by negligence and profligacy. Pack transport for the forges introduced pack trains of several hundred mules which lived on the forest and did a tremendous amount of damage to the standing trees as well as destroying any vestiges of natural regeneration; cutting by the riverside communes was quite uncontrolled and there was no attempt made at replanting the ever-increasing area of blanks, in fact, contractors and concession-holders had things all their own way. A survey of the forest conditions written in 1804 describes the damage done by firing the woods to encourage grass growth for fodder, and puts the number of grazing animals at 7,000 horned cattle and over 10,000 swine.

The 1821 Working Plan.—Overcutting continued and in 1821 a shortage of wood led to demands which produced as a result a Royal Ordinance prescribing an annual cut of 30 hectares of the Reserve, with a reservation of 8 to 10 standards per hectare, and the clearing of the soil to encourage regeneration. The reserved standards were to be removed 6 to 8 years later, so this may be regarded as an introduction of the present Shelterwood System, consisting of a seeding and a final felling without any intermediate or secondary fellings intervening between them.

The 1835 Working Plan.—A stock-taking showed that the forest now consisted of 4,500 hectares, including the central reserve, in fairly good condition, 4,000 hectares ruined and fit only for grazing, and 2,000 hectares of blanks. The new plan framed by M. de Bouffevant prescribed for the regeneration of the whole reserve, subject to a control by volume. Regeneration was obtained or attempted by various methods, a notable feature being a system analogous to our *taungya*, by which concessions were given to the riverside communes to cultivate blank areas of good soil quality for a space of 4 to 6 years, provided that they sowed the ground with acorns (supplied by the state foresters) when they put in their final cereal crop. This

method has produced some very fine stands of pure oak pole-woods which have since been underplanted with beech. Scots pine was introduced as a means of re-establishing the oak in many places where the occurrence of grazing areas and poor drainage had made the soil weed-ridden and sour. Its use as a soil improver is an unusual rôle for this species but its success is undeniable, though as a timber crop it cannot be expected to produce high class material, because it is here at the southern extremity of its geographical distribution at such low altitudes.

The 1868 *Working Plan.*—In 1868 a survey led to the conclusion that the reserve was yielding a very much higher output of first class timber than any of the younger stands, and as the scarcity of large timber was making itself felt, a more conservative policy was recommended. The attempt of this 1868 working plan to introduce a system of fixed periodic blocks must be considered as a remarkable piece of work when viewed after 60 years of practical test. The task bristled with difficulties because the forest was so far from normal stocking. The growing stock consisted roughly of two groups :—

(1) The central reserve of magnificent old trees of 180 to 200 years, already encroached upon by the fellings of the 1835 plan which had prescribed for the felling of the whole of them.

(2) The bulk of the rest, consisting of stands of less than 80 years of age, with occasional groups of slightly older trees resulting from earlier coppice fellings. Middle-aged stands of 80 to 180 years were completely absent.

The best that could be done was to divide the remaining old stands amongst the six new felling series so as to spread out their removal over as long a period as possible. Thus 1,329 hectares of these old trees were to be regenerated in the first 30 years of the 180 year rotation, and 495 hectares of the more vigorous old stands were to be held over till the second period. The ideal of rigidly fixed periodic blocks would of course have led to a great sacrifice of immature growing stock in certain places where Periodic Block II could only be completed from immature stands, but fortunately the situation

has to a great extent been saved by extensive fellings in the Scots pine crops in the 5th and 6th felling series to meet the war-time demands of 1914 onwards. As the old prescription for yield calculation was modified so that extra pine fellings should count towards the prescribed oak yield, this arrangement has allowed many of the younger oak crops to be preserved, and has given some of the old oak areas a respite. Even before the war the necessity for working other species in preference to immature oak had been realised, and provision had been made for the felling and replanting of those areas where the oak crops had previously failed and the crop consisted of beech, hornbeam, lime and pine; it was however the war-time demand for coniferous timber which made this a practical proposition.

The results of this period 1868 to 1927 can be summarised as follows:—

(*a*) *Broadleaved Species.*—P. B. I had been completely regenerated in the 1st, 2nd and 4th felling series, and partly so in the 3rd and 6th. P. B. II had been cut into in the 1st and 2nd felling series but was intact in the 3rd, while the regeneration of P. B. VI had been completed in the 3rd and 4th series.

(*b*) *Conifers.*—Fellings had been made in the II, III and IV P. Bs. of the 5th felling series, but regeneration of all these felled areas had not been completed. Pine fellings had also taken place in other P. Bs. of the 1st, 3rd and 4th series.

In spite of the complications arising out of the war-time fellings of pine, it must be admitted that the 60 years had brought about very considerable progress towards the ideal distribution of growing stock amongst the fixed periodic blocks.

The 1928 *Revision.*—The main objects of the 1928 revision were to remove the complications arising out of the war-time fellings, to remove certain weaknesses in the older technique, and to lengthen the rotation. With a rotation of 180 years and a rather long regeneration period, the felling age must be considerably less than 180 and is not sufficient to produce trees of more than 40 to 45 cm. diameter. The new rotation has therefore been fixed at 225 years by dividing each felling series into 9 periods of 25 years each.

It requires 200 years to grow the trees of 80 cm. diameter which provide the maximum yield and supply the special requirements of both the furniture industry and the *merrain* trade. The utilisable volume and quality do not increase regularly with increasing age, and the value increment consequently goes up in jumps. A tree of 50 cm. diameter gives only one *couronne* of cask staves per unit length of trunk, while a tree of 65 cm. gives two, and one of 80 cm. three. The volume of cask wood (calculating the amount of solid wood contained in the output of roughly smoothed staves), represents 47 per cent of the volume over bark in a trunk of 50 cm. diameter and 63 per cent in a stem of 80 cm. Further, the price per unit of staves is very much higher for the *tierçon* size for 500 litre casks, which can only be made out of 80 cm. stems.

Considerable quantities of large stems are cut up into planks or sent as logs for veneer to the furniture makers of Paris, Lyons, Brussels and, to a lesser extent, London. The price increment for both planks and logs is very marked, as the larger sizes sell for a much higher unit price than do the smaller ones. The increased station is therefore fully justified by market requirements, and the French fully realise that their state forests are under an obligation to produce the largest sizes of timber which are quite beyond the capacity of their private forest owners.

It is worth noting how the old oak stands have maintained their virility, for in 1835 it was proposed to cut them all within 30 years to introduce a very short rotation. In 1868 the remaining old stands were to be spread out over a further 60 years fellings, and it was not expected that they could give profitable increment beyond that period. The present vigour and continued increment of those that still remain show that the lengthened rotation of 225 years is fully justified.

In view of the uncertainty as to when the immature crops will actually be fit for regeneration, the growing stock has been grouped in three as follows :—

(1) 1,188 hectares of partially stocked old stands of over 200 years, forming the new P. B. I ;

Tronçais now has a fine system of roads, 105 kilometres metalled and 115 unmetalled. The layout in a series of *ronds-points* or stars from which 5 or 6 roads radiate outwards serves to divide it up most effectively for extraction. Expenditure on buildings, roads, and drainage of swampy ground has been reduced from 24 francs per hectare in 1928 to 18 francs per hectare in 1931, but the cost of management has more than doubled since 1923, being now about 24 francs per hectare.

RANGERS' COLLEGE PRIZE-GIVING.

The 1931-33 Forest Rangers' Course at Dehra Dun closed on 31st October when the prize-giving was held in the Board Room of the Forest Research Institute and the following speech was given by Mr. A. D. Blascheck, F. C. H., Oec. D., Inspector-General of Forests :—

We meet to-day for the award of certificates, medals and a prize to the students of the 1931-33 course of the Forest Ranger College. A class of 9 students is a small one, and it has not been possible to enjoy the full advantages of college life, but I am glad that all the students have qualified for certificates and that one student has the distinction of obtaining an honours' certificate. The average attainments of the class compare very well with the previous standard and the gold medallist, Pramathanath Bhattacharya, goes to Assam where there is so much scope for forest development.

Tours were confined to the United Provinces, but the class have been further afield than usual in visiting Bahraich and North Kheri divisions. The hill tour in Chakrata division was somewhat marred by an outbreak of chicken-pox.

Our thanks are due to the forest officers who so kindly gave their assistance during the tours, and in particular to Mr. Turner, D.F.O., Dehra Dun division, who took so much personal interest in arranging tours and helping the students to acquire all information of interest. Our thanks are also due to the Officer Commanding, Sappers and Miners, at Roorkee and his staff for a very interesting and useful course of instruction in practical engineering.

(2) a much smaller area of 175 to 200 year old crops which will probably be regenerated in the second period, but which must be carefully conserved for as long as possible, and which will meanwhile be worked under preparatory thinnings ;

(3) all the remaining crops of less than 175 years which will be thinned in the ordinary way.

The thinning cycle for pine was previously 5 years, but this has been given up in favour of a 10 year cycle for all species. Thinnings are prescribed as fairly heavy up to 60 years, heavy from 60 to 120, and light for 120 year crops and upwards.

In the 5th felling series which is to be worked under an area prescription there are 3 types of crop to be dealt with :—

(*a*) where the pine is in small pure groups with an understory of suppressed beech, the suppressed stuff is to be uprooted after a thinning has been done ; oak is then reintroduced, and the remaining pines removed when the oak is established ;

(*b*) where the pine is an open scattered crop with sufficient young oak coming on below, all the pines should be removed ;

(*c*) where the pines are mixed with poor scattered oaks, these should be removed and the pines thinned out, then replanting with oak undertaken as in (*a*) above.

The effect of lengthening the rotation has been to reduce the annual yield by 16 per cent but actually there has been a much heavier decrease in output during the three years 1929-31 owing to the very large numbers of trees left unsold and the consequent withdrawal of coupes put up for sale. The net revenue for the period 1921-28 was 408 francs per hectare per annum, but with reduced prices for all qualities of timber, and particularly for split cask staves, the revenue for the period 1929-31 has fallen to 297 francs. In 1926 one coupe of choice trees sold for 1,170 francs per m^3 over bark, and the average for the whole forest was 153 francs, but by 1931 it had fallen to 95 francs per m^3 showing fluctuations very similar to what we have experienced in India. The output has also fallen from an average of over 50,000 m^3 for the past several years to 23,000 m^3 in 1931.

All the students are recorded to have shown a creditable keeness in their training particularly during their practical work while on tour. I am sorry, however, to hear that the examiners note some tendency to sacrifice the application of experience gained in the forests for hurried cramming of text books. I hope you students will remember to develop your powers of observation in the forest, and to apply what you have learnt accordingly, and not merely as text book prescriptions.

The college is to be closed temporarily owing to restricted recruitment, but I still hope that it may be re-opened in April 1934. At any rate the temporary closure of the college need not depress you young men now starting your careers. In the first place you have qualified at a college which has a great reputation, and again the scope for forestry in India is so immense that it cannot be long before the college is re-opened.

In conclusion, I wish to thank all members of the college staff for the excellent work they have done and to you students I wish all hapiness and success in your careers.

I will now distribute the certificates, medals and prize.

Honours Certificte.

Pramathanath Bhattacharya	.. Assam.

Higher Certificates.

Chaman Lal Kapur	.. Punjab.
Daulat Ram	.. Mandi.
Hardwari Lal	.. Punjab.
Fazal Gul Khan	.. N.-W. F. P.
Sudhir Kumar Dattaray	.. Assam.
Majir Uddin Ahmad	.. Bengal.
Mohammad Shafiq	.. Punjab.
Brindaban Behari Chaturvedi	.. Gwalior.

Gold Medal for Honours. Pramathanath Bhattacharaya, Assam.

Silver Medal for Forestry. Daulat Ram, Mandi State.

Silver Medal for Botany. Sudhir Kumar Dattaray, Assam.

Silver Medal for Engineering. Pramathanath Bhattacharya, Assam.

Fernandez Gold Medal for Utilisation. Pramathanath Bhattacharya, Assam.

(Mr. Fernandez joined the Indian Forest Service in 1873 from the Nancy Forest School ; he was Director of the Forest School, Dehra Dun, and eventually retired as Conservator from the Central Provinces. The medal in his memory is provided from a fund subscribed by C. P. forest officers).

The MacDonell Silver Medal for the best Punjab or Kashmir student. Chaman Lal Kapur, Punjab.

(Mr. MacDonell was himself a Punjab forest officer who spent many years in Kashmir).

The William Prothero Thomas Prize for the best practical forester. Hardwari Lal, Punjab.

(Mr. W. P. Thomas was a C. P. forest officer and the prize in his memory is provided from a fund subscribed by forest officers in that province).

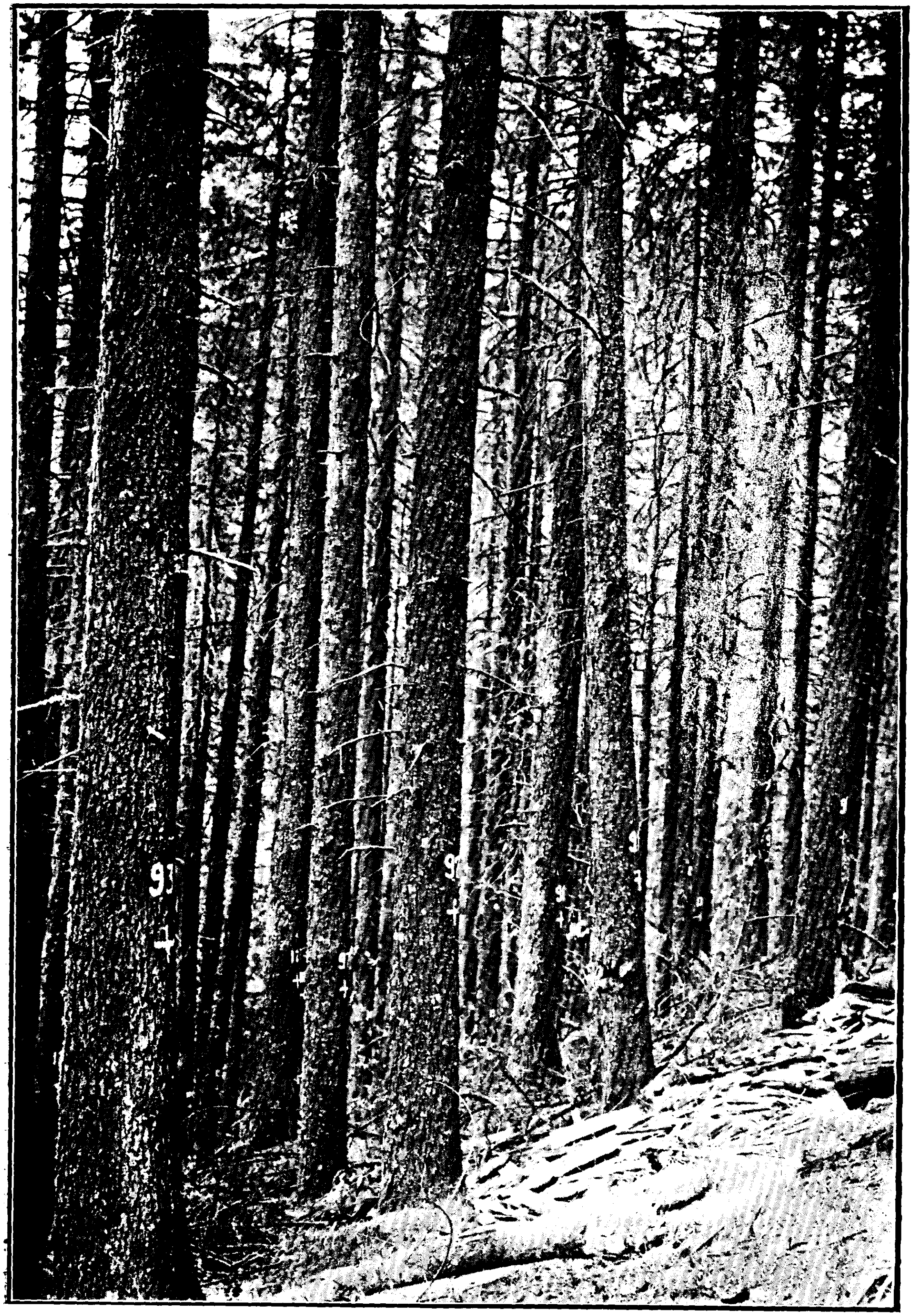
REVIEWS.

MULTIPLE YIELD TABLES FOR DEODAR.

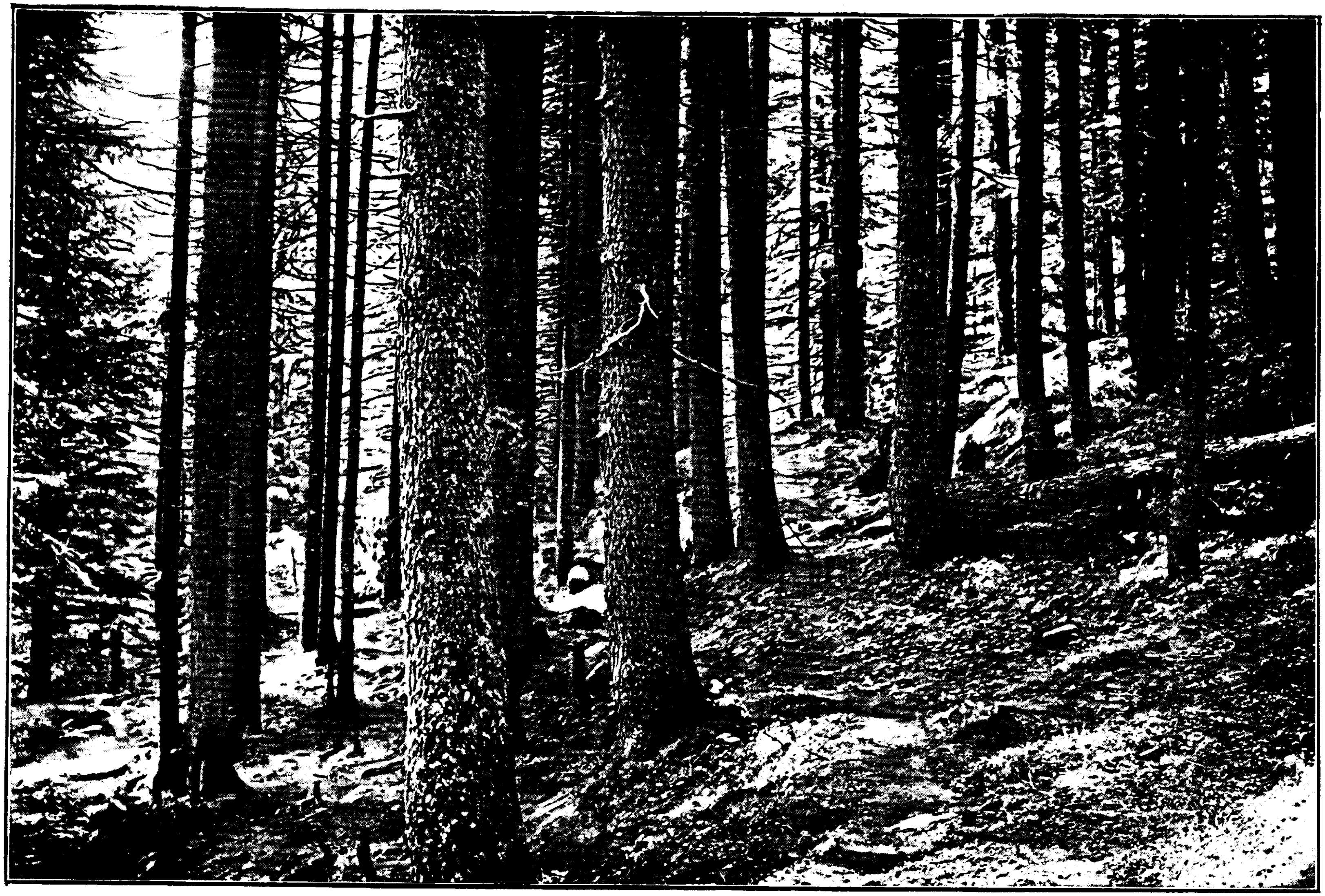
BY H. G. CHAMPION AND I. D. MAHENDRU.

(Indian Forest Records, Silviculture Series, Vol. XV, Part III). ***Price Rs.*** **4/8/-.**

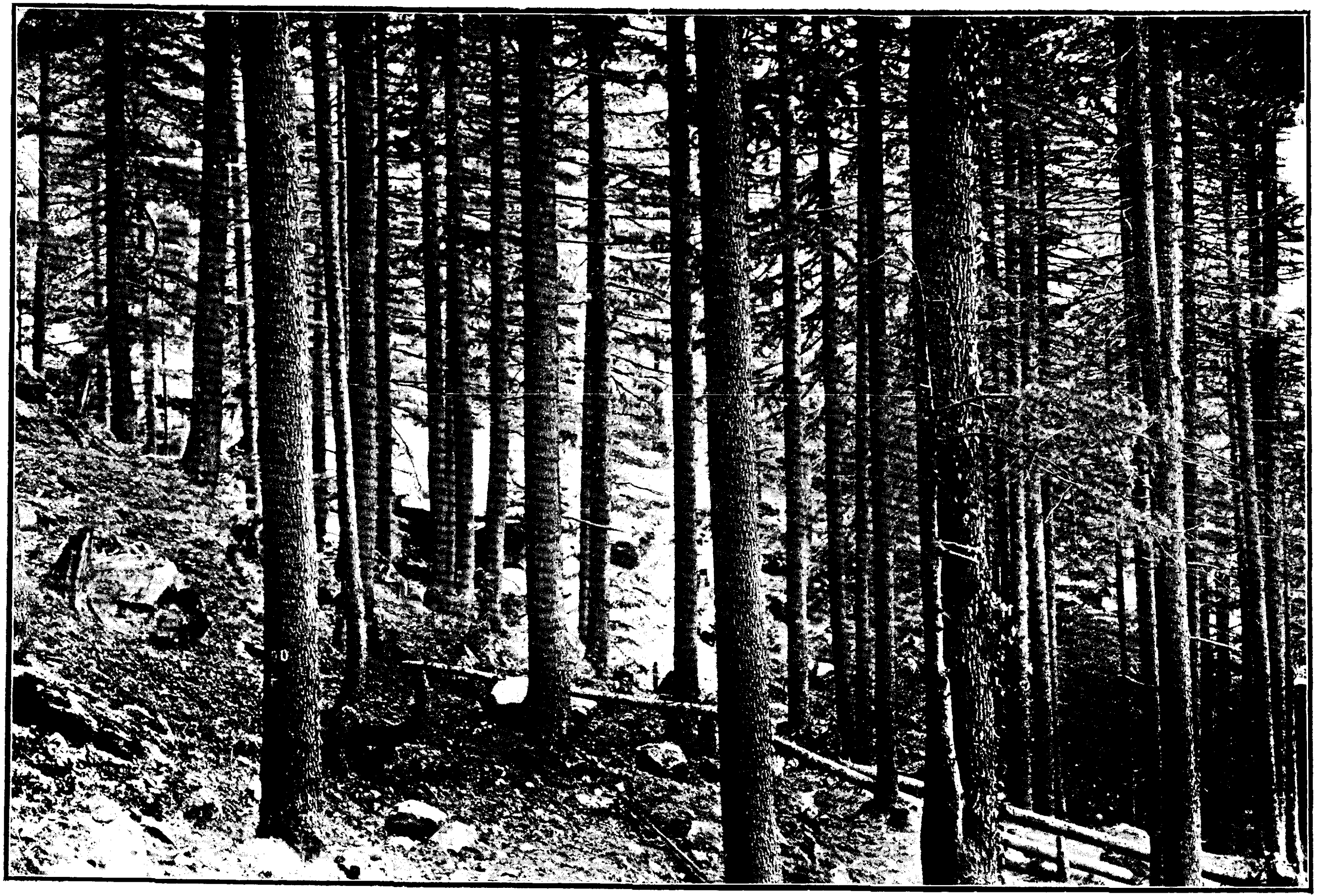
The collection of statistical data for deodar began in 1910 when Troup laid out 20 sample plots. The number was gradually increased subsequently, and in 1926 Howard published the first yield tables based on measurements in 74 sample plots. These tables have provided a useful basis for further developments, but doubts have frequently been expressed as to their applicability to future crops to be raised under systematic and possibly differentiated thinning treatment, owing to the fact that many of the plots had been laid out in crops which had, at the best, been incorrectly thinned in their earlier stages. Frequently the search for fully stocked crops had resulted in the location of plots in congested crops, and there was a general feeling that the tables did not express the same results as the management of the forests was aiming at. For example, it was thought that properly tended crops should show a much higher crop diameter at rotation ages without reduction in the quality of timber; Howard's Quality Class II shows a crop diameter of 16·5″ at 120 years with 216 trees per acre. The compilation of the work under review was undertaken mainly to test the effect of the intensity of thinning on the size and quantity of timber produced and the yield tables have, accordingly, been differentiated by thinning grades as well as by site quality classes. Field work to collect additional data was carried out in 1930 and 1931, and compilation began in 1932. Data were collected from 284 plot measurements and subsequent remeasurements in 134 permanent and 62 temporary sample plots, though some of these had to be rejected when the figures were being worked up as their data proved to be abnormal when compared with the general averages. Figures were collected from plots in Kashmir and Chamba States so that practically the entire length and breadth of the deodar belt is now represented. In the differentiation of site quality classes a departure is made from Baur's method which was used in the older tables. Top height at 120



Permanent sample plot No. 76, Chakrata Division, United Provinces, a plantation 54 years old with 272 trees per acre, crop diameter 11·2″, top height 89 feet.



Permanent sample plot No. 31, Lower Bashahr Division, Punjab, 83 years old with 229 trees per acre, crop diameter 14·5", top height 107 feet.



Permanent sample plot No. 5, Upper Bashahr Division, Punjab, 73 years old with 128 trees per acre, crop diameter 19·0", top height 122 feet.

years is used as the basis of comparison and the total range of top height at 120 years is divided into 20 feet intervals up and down from 100 feet. This procedure gives 4 site quality classes as compared with 3 in Howard's yield tables (actually the new yield tables give crop figures for 3 intermediate site qualities in addition to the 4 primary classes). The change in the methods has been carried out in such a way that a minimum of difference between the limits of the old and new classes has resulted ; a certain amount of overlapping was, however, inevitable. The new site curves are rather steeper than the old above 50 years of age and so lie above the latter, but there are indications that they will approach and finally intersect them, though with the exception of the upper limiting curve for the best site quality (140—120 feet top height) this does not happen in the 140 years for which the tables are prepared. New site quality class IV (80—60 feet) includes the lower part of Howard's class III and an additional range below it.

There are interesting notes and tables showing the distribution by site qualities of the plots by altitude and by amount of rainfall. Although all the plots situated in localities where the annual rainfall is 80″—100″ (considered to be in excess of the optimum) fall in the top 2 quality classes, it is pointed out that they are mostly young plantations and possibly may not maintain their present rate of growth. A very praiseworthy attempt was made to see whether a study of the ground flora could be used as a basis for the recognition of different types of deodar forest with different rates of growth. The results, however, indicate that a detailed differentiation of the forest into site quality classes based on a study of the associated vegetation is probably impracticable. But the author considers that, with more data, a differentiation into three broad forest types based on rainfall and flora would be tenable. This has already been done for the upper Bashahr forests in the Sutlej Valley by R. M. Gorrie in *Ind. For. Rec.* XVII, Part IV.

The classification of plots into thinning grades presented considerable difficulties as in many cases there were no reliable records of past thinnings, while several plots were unevenly stocked owing in some places to snowbreak and in others to crowded grouping.

Classification has been made on a basis of number of stems per acre after thinning for a given crop diameter. The numbers shown in the old tables were taken as representing C grade thinning and were used as a basis for classifying each plot. The five thinning grades, A to E, have been represented. Howard's yield tables represent a thinning intensity of 18 per cent, 12 per cent., and 8 per cent for I, II and III qualities for standard timber only; the corresponding figures for the new C grade, site qualities 1, 2 and 3 are 17 per cent, 14 per cent, and 14 per cent. respectively. Upto 140 years the new tables shew, for standard timber only, in all site qualities average thinning intensities of approximately 7 per cent, 14 per cent, 21 per cent, and 34 per cent, for B, C, D and E grades, respectively. The intensity shows little variation by qualities within one thinning grade.

The record gives useful notes on how the tables may be used in practice; they will be a mine of useful information for those who will take the trouble to use them. An intelligent assessment of the site quality is of course a *sine qua non* before the tables can be used. The two main uses of yield tables are the estimation of the volume and other statistical data of existing crops, and the prediction of their future development, but the authors point out that with the prevailing irregular condition of the deodar forests, the second use is the more important, particularly where it is desired to fix the rotation, conversion period, etc. In addition the tables will be found useful for testing volume, yield and increment per acre, density and degree of normality. Partial yield tables for crops enumerated down to 12″ diameter have also been prepared; these should prove very useful since enumerations are not often carried out below this limit in deodar crops; if they were, similar tables down to the required limit could easily be prepared on the same lines.

The following tables which are given, add to the completeness of the work :—

(1) Stand table; this gives the percentage of stems up to given diameter limits in crops of various diameters corresponding to the condition after a thinning has been done.

(2) Number of trees per acre by average diameter and thinning grade.

(3) Spacement table by average diameter and thinning grade.

(4) Total yield of stem timber by average height and thinning grade. This table has been prepared as it is useful to have data on a basis independent of age; for example, where trees have not been felled for ring-counting. The table brings out the difference in total yield in crops of the same height but different thinning treatment.

(5) Normal growing stock (stem timber) for 100 acres for rotation age of 100, 120 and 140 years.

(6) Comparison between E grade thinnings and optimum growth as determined from crown measurements and correlating the average diameter and number of stems for these two conditions.

The yield tables provide every means of testing the condition and development of deodar forests and they indicate the lines on which different crops should be treated and how they should react to treatment. The correct thinning of deodar crops has for long been a matter of controversy but the publication of these tables will leave little in doubt.

The tables show that the thinning grade has but little effect on the *total* yield within one site quality, though there is of course a large difference in the proportions of the final yield and thinnings yield. Deodar is only marketable in large sizes and it is clear that the thinning treatment must be such that crops of the required average diameter will be produced under a reasonable rotation. The tables, further, suggest that long rotations, particularly in crop of low site quality, are inevitable. Insufficient data are available at present to show the effect of the different thinning grades on the quality of the timber, but the table comparing optimum growth figures with those of E grade thinning are interesting. This question of crown measurements is an important matter, and a good beginning has been made. The next step should be the preparation of Money Yield Tables; the Central Silviculturist's branch has given a lead, and it should not

be too much for the Provincial Silviculturist to carry on with the preparation of the money tables.

This is the first time that multiple yield tables of this nature have been prepared outside Europe. The authors are to be heartily congratulated on their efforts. The amount of office work involved was out of all proportion to the result, and it would not be far from the mark to say that three-quarters of the work was expended on trial lines, the results of which finally had to be rejected.

A. P. F. H.

REPORT OF THE PUNJAB EROSION COMMITTEE, 1932.

The Report is brief and deals with the damage done in the submontane tracts of the Punjab. Mr. Holland's Report of 1928 is accepted as representing a true picture of the state of these tracts. The Committee held ten sittings in all, four at Lahore, two at Hoshiarpur, two at Dharamsala, one at Chandigarh and one at Simla. A number of official and non-official witnesses were examined. The summaries of their evidence and written memoranda are given in 7 appendices attached to the Report. The Committee has made recommendations with respect to three districts only, *viz.*, Kangra, Hoshiarpur and Amballa and have decided to make no recommendations for the time being for other tracts. The Committee, quite naturally, gave more weight to non-official evidence which was on the whole hostile to any proposal that might restrict their grazing rights or tend to reduce the number of cattle which, they allege, they have been keeping since time immemorial. The official evidence is on the whole satisfactory and there is a general realisation that the danger of erosion has reached a point when some sort of action by Government is necessary.

2. On going through the resolutions of the Committee it is seen that the gravity of the situation is realised though consolation is taken in the fact that there was still no evidence that the *rabi* supplies of water in the large rivers were likely to diminish in the near future.

3. The recommendations of the Committee are, on the whole, on the right lines but they do not go far enough. In spite of opposition by non-official witnesses the Committee have recommended the application of Section 5 of the Chos Act to the following tracts :—

(*i*) To selected villages (not specified in the Report) on the western slopes of the Siwaliks in the Hoshiarpur district with the proviso.

(*a*) that the present system of blocks A, B and C would be abolished, and

(*b*) that the cutting of trees would be permitted under suitable restrictions.

(*ii*) To some villages (specified in the Report) on a strip along the Patiala State boundary in the Amballa Siwaliks.

There is also a very welcome proposal that the Forest Department should be more closely associated in this work than they have hitherto been. It is recommended that the Divisional Forest Officer, Hoshiarpur division, should act as an assistant to the Deputy Commissioners of Hoshiarpur and Amballa with regard to the protection and afforestation of the Katardhar in Hoshiarpur and the Siwaliks in the Amballa district. In the end there is a recommendation that a whole time forest officer should be appointed to study the question of the reclamation of *cho* beds on the lines laid down in the book "Regulation of rivers without Embankments" by F. A. Leete, C.I.E., I.F.S. They further state that this officer, if appointed, should also take over the work in the Hoshiarpur and Amballa districts which was originally recommended to be done by the Divisional Forest Officer, Hoshiarpur division. It is, indeed, a happy sign that a Committee containing a majority of non-official members should realise the importance of associating the Forest Department in this very important work. And this, in spite of the fact that every non-official witness examined by the Committee showed a distrust of the aims and policy of the Forest Department.

4. Turning to the appendices attached to the Report, appendices 1, 2 and 3 give the summaries of evidence recorded in the

Hoshiarpur, Kangra and Amballa districts. These are well worth studying as representing the views of those most affected by erosion and on whose co-operation and sacrifice depends the success of any scheme that will ultimately be evolved to combat this evil. Appendix 4 contains the memorandum presented by the Forest Department. Copious extracts, facts and figures have been given to bring home the injurious effects of erosion and the matter has been discussed from every angle. Remedial measures on the lines of those undertaken in foreign countries have been suggested, which, if acted on, would produce the happiest results. The memorandum is on the whole well worth reading and should serve as an eye opener to the inhabitants in the plains districts who are still unaware of this creeping danger descending on them from the hills. Appendix 5 contains a memorandum by Mr. Brayne, I.C.S., who did such excellent reclamation work in the Gurgaon district. He is all for propaganda and education of the populace about the usefulness of their forests and the danger that is threatening them. Appendix 6 contains the written replies received from some civil districts and from the various States in the Punjab. Appendix 7 contains a proposal for the training of *chos* in the plains. The writer draws the analogy from the flow of rivers and nallas in the plains and tries to apply some observations made by him to the *chos* (hill torrents). The analogy is not at all applicable as the origin of these rivers and nallas is different from the *chos*. The *chos* are a direct result of heavy rain falling on denuded hillsides, which when fully saturated result in huge landslips. A considerable amount of material is eroded which comes down in a tremendous rush causing general devastation. The *chos* do not flow in loops and bends, as presumed by the writer, and no amount of human effort can change their course even slightly. The main remedy lies in afforestation and restriction of grazing in the catchment areas, and this proposal is simply a palliative when desperate remedies are needed to stop the devastation caused by *cho* action.

5. Pandit Nanak Chand, M. L. C., has writen a minute of dissent urging more drastic official action with which every forest officer will be in complete agreement. But the position has to be faced. Government is, at present, not in a position to spend large sums of money.

Besides, there are no signs of any efforts made by individuals which could be supplemented by aid from the Government. Pandit Nanak Chand's views are of a man in a hurry who would like to see things done in a day, where it has taken years in other countries. Proper realisation of danger by people has not yet come and till that is done and till the people are ready to make sacrifices, I am afraid, there is very little the Government can do to help them. A reference to the memorandum submitted by the Forest Department will show what other countries are doing in this direction and the extent to which private enterprise is coming to the help of the Government. It is, on the other hand, the duty of the Government to declare their policy as to how far and under what conditions are they prepared to help private enterprise in this direction.

D. D. SAIGAL.

THE JUNGLE IN SUNLIGHT AND SHADOW.

BY F. W. CHAMPION, M.A., F.Z.S., I.F.S.—CHATTO AND WINDUS, 21 SHILLINGS.

Mr. Champion's previous book of jungle pictures, "With a Camera in Tigerland," has given so much genuine pleasure to multitudes of nature lovers both in India and elsewhere that the advent of his second book will be welcomed by many. They should certainly not be disappointed, for the new book is an advance in many ways on its predecessor, notably in the technical skill of animal photography in which Mr. Champion is now a recognised authority, and in the fluency and interest of the letterpress which is written around these pictures.

The book is beautifully produced and the reproduction of about 100 plates does full justice to the author's photographic skill—a happy state of affairs which must fill with envy the heart of those unfortunates whose responsibilities include the reproduction of half-tone illustrations by printing firms in India! In addition to fresh studies of tiger and leopard in their native haunts which formed the

main feature of the previous book, this volume contains many excellent studies of the lesser known animals such as hyænas, pangolins, ratels, foxes, porcupines and jungle-leopard and fishing-cats. There are also several fine studies of wild elephant, bear, swamp deer, sambhur and cheetal in their native haunts, some of the latter bringing out most forcefully the great value of protective colouring.

Some of these pictures and portions of the letterpress have already appeared in one or other of the leading illustrated magazines, and as is inevitable with such a series of disconnected articles, the notes show a tendency to repetition of certain arguments and aspects. When this is to emphasise the persecution of game and the rôle of forest reserves in affording them better protection, however, no harm and much good may be done by convincing the unbeliever. The author makes two points to which he frequently harks back—one is that with the universal persecution of the tiger by *shikaris* armed with modern rifles, this magnificent animal is likely to be reduced so seriously in numbers as to upset the balance of nature, leading to an excessive multiplication of deer. This is a point on which all forest officers will doubtless agree except for those areas of Southern India where the tiger's natural prey have been so ruthlessly exterminated that he has turned cattle-thief and man-killer for lack of his usual jungle menu. The other point, which may not meet with such universal acceptance, is that the jungle is essentially a happy place full of eager contented livestock which only occasionally experience moments of passing fear and unhappiness. That this is a truer picture of the average jungle than the terror-stricken gloom depicted by many sensational novelists and film makers most of us will be prepared to admit, but Mr. Champion's insistence upon it reminds us of the definition of a pessimist as "one that lives with an optimist"!

A leader in *The Statesman* of 12th October gives a very full review of Mr. Champion's book and the reviewer accuses him of perpetrating a gigantic leg-pull on the subject of the gentle and harmless tiger. All generalisations on the subject of game animals are more or less dangerous, but we can reassure *The Statesman* that there are actually a good many forest divisions in North India where the villagers

would prefer to have the excess deer destroyed rather than have the local tigers done away with. Examples of this are to be found in parts of Pilibhit, Haldwani, Ramnagar, Kheri and Lansdowne in the U. P., Kurseong and Buxa in Bengal, and parts of Central Provinces such as Mandla. Even in these of course the position varies every few miles. Incidentally the deer damage affects the crop-owners who may have little in common with the cattle-owners (generally cartmen or professional graziers) so that the views of these two communities may be diametrically opposed ;—the crop-owners would have the deer destroyed, while the cattle-owners would have them preserved so that "tigger" can get fat on the deer and leave their cattle alone.

Looking at this book from the point of view of the forest officer as to how it will depict his life and work to a much wider public than is usually allowed to our "silent service," one finds frequent references to the value of timber and jungle produce and to the vast numbers of villagers who depend upon forest work for their wants and their livelihood. Thus far the impression is good. There is however a somewhat ominous silence on the subject of the duties and activities of a forest officer, and the casual reader could hardly be blamed if he formed an impression that a Divisional Forest Officer's tour programme is decided on the spur of the moment by following the freshest tiger pug-marks from one forest bungalow to the next! Apart from one reference to office work during the rains,—interrupted to climb trees in pursuit of a nesting flying squirrel :—and another to "a fortnight's rest and change" in an ideally situated forest rest house, there is little to indicate how the forester who has not Mr. Champion's enthusiasm for photographing wild life, spends either his working hours or his leisure moments. Possibly the author intentionally avoided this aspect of jungle life, but as one of the denizens of the forest surely the habits of the normally behaved Divisional Forest Officer are worthy of a few brief references. The outside public's ideas on a forest officer's occupation are usually confined to "what *do* you do in the jungle ?" and we doubt if the book under review will do much to enlighten them!

From the zoologist's point of view, however, the book is full of good things. As definite contributions to scientific knowledge we should mention the observations on the habits of the ratel, the pangolin or scaly anteater, the fishing-cat and the hyæna, the interesting chapters on the senses of the tiger, curiosity in animals, and amongst his "Jungle Riddles" the interrelationships of wild dogs, jackals and langoors with tiger and leopard.

Doubtless the author's most carping critics will be his fellow forest officers, for some professional jealousy is perhaps inevitable, particularly amongst those who have already tried the photography of wild animals but have been less triumphantly successful than Mr. Champion has been, either through lack of skill or less fortunate posting. The green eye of jealousy however should not prevent us from congratulating him very heartily upon producing such a notable and distinguished contribution to the literature of jungle lore.

R. M. G.

A NOTE ON THE HISTORY OF THE CHENAT NAIR FOREST EXPLOITATION SCHEME.

BY J. A. WILSON, I. F. S., 1933 (GOVERNMENT PRESS, MADRAS).

It is not often that a government or department advertises its mistakes, and for this reason alone this pamphlet of 31 pages is refreshing reading. In it the author describes in historical sequence the small beginning, the snowball progress, and the final collapse of the Chenat Nair Exploitation Project in Madras. He does not attempt to justify the venture nor does he try to find excuses for its failure, but he presents the facts, supported by reliable figures, to show just where and why the scheme did not bear fruit. For this reason the Note is one which is of considerable value to anyone, be he a private individual or a government servant, who is contemplating any venture connected with forest exploitation, sawmilling, kiln seasoning or marketing timber, and the Forest Department of Madras are to be congratulated on putting down in black and white the history of this unfortunate venture.

The pamphlet contains a great deal of valuable information on the costs and output of sawmilling (as conducted at Olavakkot) and on extraction costs, and the fact that these figures are on record is in itself a justification for the publication. Some additional notes on labour, seasoning, markets, and the individual characteristics of the numerous woods handled, make the publication one of exceptional merit, since the remarks made are the result of practical experience, and there is no better teacher than that.

H. T.

EXTRACTS.

ECOLOGY OF PINUS LONGIFOLIA IN KANGRA AND HOSHIARPUR FOREST DIVISIONS.

BY N. P. MOHAN, I. F. S.

I.—Introduction.

1. The caption of this paper is somewhat ambitious as finality is not claimed for all the observations recorded. Material has been collected according as the opportunities for doing so have arisen. The record for obvious reasons has not, therefore, been continuous. An attempt has been made to avoid covering the ground treated in readily accessible books and publications.

II.—Phenology, Structure and Life History.

2. The habit, physiognomy and growth form of any plant are determined by the nature of the genes (including their inter-relationship and position) and the environmental complex. The time of the commencement of the vegetative activity, resting periods, the adaptations and the general life history have a meaning or should have a meaning which should unravel phenomena, the understanding of which should result in the applicability of natural treatment in silvicultural operations. In the natural study of any plant, the determination of its life history is of considerable importance.

3. Of the four or five species of Himalayan pines, *Pinus longifolia* is found at the lowest altitudes and is cultivated in some of the gardens of the Punjab plains. The young tree at first produces only the male cones and the lower branches of older trees also generally bear the male cones. The female cones are borne by the topmost branches, but occasionally the lower shoots also bear the female cones. Branches are thus generally either male or female, but in a recent issue of *Current Science* (1), description of peculiar cones of *Pinus longifolia* is recorded. "The terminal portions of the cones are occupied as in the normal female cones by a compact group of megasporophylls. Below this zone, on the same axis of a few cones, there is a circlet of male cones varying in number from 1—10 and smaller than the normal male cones. In some others the male cones are inter-mixed with female cones ranging in number from 1—5. These axillary female cones are much smaller than the axillary male cones and the terminal female cones." Amongst the lower branches it is rare to find male shoots being given off by female shoots but amongst the upper shoots female shoots occasionally do give rise to male shoots.

4. On a male branch the successive remains of whorls of the scales which protect the male cones give an idea of the age of the branch and such whorls can be counted for 10 years or sometimes more. The male branch first produces the male cones and then the dwarf shoots. The branches on which series of successive whorls can be counted are almost equal in diameter at their apex and base provided they are unbranched. This tends to show that very little (if any) secondary growth takes place in these shoots. If, however, these shoots are branched, vigorous secondary growth takes place in the parent axis. Occasionally, in the cluster of male cones, a few of the cones are replaced by dwarf shoots. On the evidence from abnormalities and from the position of dwarf shoots on the shoots of unlimited growth, the male cones and dwarf shoots are supposed to be homologous organs. The comparative weakness

and pendulous nature of the shoots bearing the male cones may be an adaptation for securing more efficient dispersal of pollen. In Kangra it is further secured by the strong February and March winds which blow down the dead needles and make the trees appear devoid of a considerable part of their foliage. Well stocked forests, during these months, appear as thinly stocked.

5. On a female branch, cones of four or five " generations " can also be readily counted. Female branches produce first the dwarf shoots and then the female cones. The position of female cones in the upper parts of the trees may be an adaptation to safeguard their life from injuries to which the lower branches may be exposed or it may be designed to intercept the active rays of the undiluted spectrum.

6. Male cones are initiated in Lahore in Spetember. They continue to grow throughout the winter, become conspicuous in the beginning of February and begin to shed their pollen from the middle of that month. Slightly later is the development at the low altitudes and later still at higher altitudes where the pollen may commence to be shed as late as the end of March or beginning of April. The sequence of development in the male cones at Lahore, as found by Dr. Sethi (2), is given in table 1. It should be borne in mind that all cones in a cl ster are not at the same stage of development. The dates in the table are given for those at the base of the cone ; those at the apex are usually younger at the dates given in the table :—

TABLE 1.

	Particulars.	*Date.*
1.	Initiation of the cluster of male cones ..	September.
2.	Microsporophylls become distinguishable ..	Early October.
3.	The fertile proximal part of the microsporophyll is marked off from the sterile distal part ..	18th October.
4.	Three or four wall layers of the sporangia are defined ..	11th November.
5.	Cells of the outermost layer of the wall get filled up with resin	By the 15th Decr.
6.	Most of the cells of the sporophylls and cells of the wall except the two innermost layers get resiniferus deposit	By 24th January.
7.	Pollen mother cells and mother cell stage recognisable	January.
8.	Reduction division ..	23rd January to 1st February depending on climatic factors.
9.	Shedding of pollen ..	From middle of February.

It should be noted that sporogenous cells are in an actlve state of division in December, *i.e.*, mid winter. The development of the pollen, as compared with foreign species of *Pinus*, takes place in a leisurely fashion ; the first few stages take more time and the last few less time.

7. In Lahore, January sees the initiation of female cones produced in groups of 2—5 at the termination of the youngest female shoots. These small cones have a reddish green colour. Ovules are organised about three weeks before pollination which takes place during the latter half of February or the first half of March (depending on the locality). Cones then continue to grow till May when they are about one inch long. Then ensues a period of rest and in this condition the external colour of the cones is brown. Growth is resumed in February and the new parts of the ovuliferous scales become green. The apical brown region of these scales is carried up and thus shows the growth of the previous year. The life history, as worked out by Dr. Sethi (2), for Lahore is given in table 2.

TABLE 2.

	Particulars.	Date.
1.	Initiation of female cones ..	..January.
2.	Ovules show the integument and nucellus	..Middle of February.
3.	A deep seated megaspore mother cell visible	..18th to 22nd February.
4.	Megaspore-mother cell growing ..	..Succeeding three weeks.
5.	Reduction of the megaspore-mother-cell ; formation of the bivalent chromosomes ; possible formation of the linear tetrad ; differentiation about the megaspore-mother-cell when the latter enters upon the first heterotypic division ; formation of a few free nuclei	..Up to May.
6.	Resting period	.. May to January.
7.	Resumption of growth ; the new parts of the ovuliferous scales become green	..February.
8.	Vigorous development of the endosperm	..February and March.
9.	Peripheral layer of cytoplasm with free nuclei visible	..End of March.
10.	Development more rapid and endosperm fully mature, Complete formation of female prothallus ..	..April.
11.	Fecundation (for Lahore). ..	..End of April.
	,, (for Chamba). ..	..July.

8. Cones attain their full growth of 4½" by the end of July or August and after that the external change is from a green fleshy texture to the brown woody cone (3). The seed ripens by December. When mature, summer-heat opens the cones in June and the seed falls to germinate within 2-3 weeks of the commencement of the monsoon.

9. It is interesting to compare the life history of *Pinus longifolia* with that of *Pinus laricio* at Chicago. The development of the female cone in both the species takes place at about the same time ; but in the case of *Pinus laricio* it continues till October when the resting period begins, *i. e.*, the resting period begins with the commencement of winter. In other words the cones in *Pinus laricio* continue to grow throughout the summer but those of *Pinus longifolia* stop their growth in the beginning of summer. Table 3 compares the life history of the two species (2).

Table 3.

Particulars.	*P. laricio* at Chicago: Lat. 41 50′ N: Long. 87 37′ W.	*P. longifolia* at Lahore: Lat. 31 30′ N: Long. 74 15′ E: Alt. 720′.	*P. longifolia* at Chamba: Lat. 32 29′ N: Long. 76 10′ E: Alt. 3,027′.
Initiation of female cone.	Late autumn and winter.	January ..	..
Megaspore mother cell.	May ..	Middle February.	..
Reduction division in the megaspore mother cell.	..	End of February or early March.	..
Second winter condition of the female prothallus.	Parietal layer of free nuclei.	A few parietal nuclei.	..
Cutting off of the ventral canal cell.	21st June ..	21st to 29th April	..
Syngamy ..	1st July ..	30th April ..	1st July.
Pollination ..	Mid June ..	February ..	..

The striking feature in the above table is the same date at which syngamy takes place in *P. longifolia* at Chamba and in *Pinus laricio* at Chicago. It is possible that schedule for *Pinus longifolia* in Chamba may be identical with *Pinus laricio* in Chicago.

10. The foregoing paragraphs indicate that the winter is the season of intense activity in the floral parts and that the first half of winter is comparatively less active. The resting period is the summer and the rest may be in response to adverse growth factors,—insolation, drought and fires. The extent to which silvicultural treatment should be determined or modified, with reference to the development of ovules and the subsequent development of seed, will be dealt with under silvicultural operations.

11. It is not perhaps unreasonable to conclude that the schedule of development in Hoshiarpur and in the low hills of Kangra is similar to Lahore while the higher hills of Kangra correspond more to Chamba where the development takes place two months later. It follows that it will be incorrect to determine all winter silvicultural operations at one and the same time throughout the *chil* zone in Kangra and Hoshiarpur divisions.

12. The needles persist on the trees for two or at the outside for three years. The needles of *chil* trees at lower altitudes are longer than the needles of trees at higher altitudes. It remains to be determined if this difference can be explained by Huxley's law of relative growth (4) or by a system of Cartesian ordinates (an exercise in higher geometry). The needles at higher elevations and in more favourable situations are green but in warmer localities they tend to be bluish green. This change in colour may be a xeromorphic character or may be a response to different light conditions. It is possible that *chil* produces both light and shade needles; at any rate, in one of its associates, *Carissa spinarum*, light and shade leaves and forms can be easily made out.

III.—The Environmental Complex.

13. *Chil* is a summer monsoon plant in the Himalayas, *i. e.*, its germination takes place with the commencement of the summer monsoon. If the monsoon rains fail, all other factors remaining the same, regeneration of *chil* will be impossible. To put it in another way, the period of greatest rainfall follows the time of sowings. Heavy mortality occurs during the dry period in autumn and heavier still during the summer dry season. The latter in fact is the critical period. Table 4 shows the amount of rainfall in inches at different stations in the *chil* zone :—

Table 4.

Province.	Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
United Provinces.	Almorah (10) ..	2·08	1·89	1·97	1·09	2·14	5·73	10·35	9·87	5·17	1·27	0·23	0·61	42·40
	Kansani (10) ..	2·79	3·04	4·09	1·78	4·59	8·23	16·07	15·28	6·23	1·64	0·64	0·83	65·21
	Ranikhet (10) ..	2·54	2·32	2 16	1·31	2·14	5·50	13·01	13·89	6·52	1·52	0·36	0·88	52·15
	Champavat (11) ..	2·56	3·07	2·45	1·11	2·96	7·52	15·10	13·17	8·27	1·89	0·41	0·77	59·31
	Pithoragarh (11) ..	2·05	2·34	1·75	1·20	3·06	7·20	12·32	11·17	5·78	1·21	0·23	0·52	58·83
	Berenag (11) ..	2·82	2·89	2·39	1·48	3·91	10·87	18·82	20·49	9·58	1·63	0·45	0·83	76·16
	Chowkoori (11) ..	2·95	2·86	2·33	1·23	3·66	14·31	28·26	31·67	13·85	1·90	0·48	0·68	104·18
	Dharchula (11) ..	1·81	2·00	2·44	1·07	2·62	9·36	17·32	17·85	6·95	1·57	0 55	0·61	64·15
Punjab.	Kahuta (12) ..	1·47	2·94	2·38	1·96	1·32	2·39	8·30	10·66	5·04	0·72	0·08	2·45	38·71
	Murree (12) ..	2·96	6·03	4·84	3·69	3·56	3·49	11·43	15·27	7 74	1·73	0·29	2·27	63·30
	Palampur (13) ..	4·26	3·59	2 52	1·69	3 27	5·31	32 74	36·22	9·91	1·00	0·62	3·43	104 56
	Dharamsala (13) ..	3·89	3·81	2·52	1·83	2·51	5·80	37·06	41 33	11·53	1·02	0·83	3·34	115·47
	Kangra (13) ..	2·69	2·41	1·62	1·15	1·97	2·52	23·97	29·78	6·11	0·60	0·47	2 22	75·51
	Nurpur (13) ..	2·64	2·25	1·59	0·62	1·33	3·26	17·65	18·19	5·44	0·85	0·58	2·67	57·07
	Dehra Gopipur (13) Outside *chil* zone.	1·88	1·85	1·25	0·92	1·79	2 27	16·24	15·63	5·07	0·67	0·35	1·81	49·73

14. This table brings out the fact that *chil* occurs at places with annual rainfall varying from 38″ to 115″. Too much reliance on the annual rainfall for the determination of the type of vegetation is unsafe if not incorrect. Ecologists, all the world over, are of opinion that " degree of wetness " is of greater importance than the figures for annual rainfall. Degree of wetness is determined by the following formulæ :—

(1) Degree of wetness of each month or group of months=inches of rain × No. of rainy days/10. (A rainy day is a day on which the recorded rain is or exceeds 0·01 inches.)

(2) Degree of wetness of the whole year=inches of rain × No. of rainy days/100.

Calculations are generally made on the basis of the whole year (2nd formula) but it has been found in some cases that the " degree of wetness " so determined does not correspond closely to the zones of vegetation and it has been suggested (5) that the rainfall of the dry season, rather than that of the whole year, should be considered as the factor limiting the growth of the various types of vegetation.

15. For the verification of this suggestion it is necessary to find the number of rainy days and this is generally not available in many of the publications. The driest month in the whole zone is November but this is neither the critical month nor is it possible to say with the data available if this is the month of the highest saturation deficit. From practical experience, it is inferred, that the driest months are April, May and June. Division of time by months introduces an arbitrary distinction but this is unavoidable. Assuming, however, the number of rainy days to vary between *x* and *y*, the degree of wetness of the Kangra stations will be as under :—

Palampur $= \dfrac{10{\cdot}27 \times (\text{a figure between x and y})}{10}$.

Dharamsala $= \dfrac{10{\cdot}14 \times (\text{a figure between x and y})}{10}$.

Kangra $= \dfrac{5{\cdot}64 \times (\text{a figure between x and y})}{10}$.

Nurpur $= \dfrac{5{\cdot}21 \times (\text{a figure between x and y})}{10}$.

Dehra Gopipur $= \dfrac{4{\cdot}98 \times (\text{a figure between x and y})}{10}$.

If the existence of *chil* can be taken as a constant all equations, except that for Dehra Gopipur, will have an equal value. If this is so, then the rainy days at Kangra and Nurpur will be nearly twice the number at Dharamsala and Palampur. Or it may be that the *chil* occurs within a fixed range. I regret the calculations cannot be carried further because the number of rainy days is not available.

16. It must, however, be emphasised that the above suggestion takes into account only one factor namely moisture and ignores the other equally important factor, heat. Any type of vegetation or its dominant constituent must attune itself, if it is to exist at all, to the minimum of rainfall and to the maximum of temperature. The former is the degree of wetness (*w*) during the critical period of April, May and June, and the latter will be the maximum (*t*) attained during this period. Whether any mathematical relation exists between *w* and *t* is a subject under investigation.

IV.—*Forest Types.*

17. The environmental complex expresses itself in the form, structure and composition of the vegetation, which for a given set of conditions, can be reckoned as the climax vegetation. A change in this climax can only be caused by a change in the factor of the locality (using the term in a comprehensive sense). Conversely, the nature of vegetation should signify the nature of the environment. Continuity of the same kind of association should indicate the same or similar (in effect) set of factors of the environment. It is, therefore, instructive to ascertain the kind of vegetation which has clothed the surface of the locality from time to time.

18. Embedded in indurated, shaly, bluish and slightly micaceous clay in the rocks of Kasauli range (probably of middle tertiary age) were found a number of well preserved remains. Their comparatively perfect state of preservation and maturity pointed to their having been separated naturally from trees or plants to which they belonged and precluded the possibility of their having been carried from other regions. They evidently flourished in the vicinity of rocks in which they were fossilised. The natural families represented by the specimens are given in Table 5.

Table 5.

Natural Family.	Genus.	Present habitat.
Sapindaceae ..	Nearest approach to *Sapindus dubius.* Unger.	Essentially tropical. India and tropical part of South America.
Ericaceae ..	Close resemblance to *Andromeda vaccinifolia, Flora tertiaria Helvetiae.*	No characteristic habitat. Both within and without the tropics. In the former on high lands. Rather rare in India.
Lauraceae ..	Referable to genus *Tersia*; species *Branuni* and genus *Larus.*	Cool places of the tropics of either hemisphere. Northern India and lower zone of Himalayas.
Moraceae ..	Various specimens of genus *Ficus* and one identical with *Ficus religiosa.*	Tropical and sub-tropical.
Cycadaceae ..	Genus not identifiable ..	Tropical.
Coniferae ..	Several acerose midribbed leaves and fragments of cone scales but too badly marked to admit of generic identification.	Sub-tropical and temperate.
Palmaceae ..	Closely allied to *Flabellaria rapitifolia.* Sternburg.	Tropical.
Cyperaceae ..	Cyperites, some allied to *Deucalinois.* Heer: species *Tennis tritis*; Fragment of *Carices.*	Evidently tropical; but met with in marshes, ditches, meadows, heaths, groves, forests, running streams, blowing sands of sea shore and tops of mountains from Arctic to Antarctic.
Gramineae ..	Referable to *Poacites* ..	Various.

It is concluded that the climate during the deposition of the blue shaly clays of Kasauli range was very much the same as that which obtains now in the locality whence these vegetable remains have been derived. The "rank and various" vegetation of the Kasauli period is proved by the great number of genera represented above. Allowing for the elevation of the Kasauli beds in common with the whole mountain mass, the latitude in which Kasauli beds were deposited at the time of their deposition, was, as now, generally favourable to the sub-tropical forms of vegetable life.

In treating the fossils as "the thermometers of the past" there is, it should be stated, always a risk of an inaccurate conclusion. The inference that the tertiary species required a warm region because the living and related species are confined to a similar region is obvious, but it must be remembered that the majority of tertiary plants are not specifically identical with living forms ; that many closely related species live under very different conditions ; that it is impossible accurately to determine the precise relative susceptibility to external factors of extinct and living plants ; and that it cannot be asserted with confidence that in the earlier days of its career a genus or a species responded to climatic influences exactly as it does to-day (6).

19. The low hill vegetation (*chil* and scrub) of Kangra and Hoshiarpur divisions can be classified from two points of view, *viz.*, (*i*) Forest types and (*ii*) Growth forms.

I.—Forest Types.

(Altitudes mentioned under 'A' are not to be taken as indicators or limits of the forest types concerned ; they are only for general guidance.)

A. Chil Areas.—The chil associations are composed of :—

(*i*) Between 1,800 to 2,500 feet. *Carissa spinarum, Dodonæa viscosa, Woodfordia floribunda, Mallotus philippinensis, Acacia catechu, Cassia fistula, Phyllanthus emblica, Kydia calycina* and *Odina wodier ;* in somewhat moister parts, *Anogeissus latifolia* and *Indigofera* spp. ; and in depressions *Ougenia dalbergioides, Milletia auriculata, Xylosma longifolium, Eugenia jambolana* var. *caryophyllifolia* and *Bauhinia vahlii.*

It should be noted that many of the scrub species are due to the retrogression caused by fires. Where fire damage has been non-existent, *Carissa spinarum* is almost the only and the principal associate.

(*ii*) Between 2,500 and 3,000 feet. The miscellaneous scrub growth very largely disappears unless the canopy is very open or the area has suffered from fires. The chief associates are *Carissa spinarum, Dodonæa viscosa, Woodfordia floribunda, Mallotus philippinensis, Eugenia jambolana* var. *caryophyllifolia, Machilus* spp. and *Anogeissus latifolia.*

(*iii*) Between 3,000 and 3,500 feet. The principal species in areas burnt by fire are *Carissa spinarum, Dodonæa viscosa, Woodfordia floribunda, Mallotus philippinensis, Indigofera* spp., *Rhamnus triqueter* and *Casearia tomentosa* ; while in the forests in which no fires have occurred, the chief associates are *Carissa spinarum, Pyrus pashia, Quercus incana, Rhododendron arboreum* and *Pieris ovalifolia ;* some *Mallotus philippinensis* and occasional *Albizzia stipulata.*

(*iv*) Between 3,500 to 4,000 feet. *Berberis* spp. mixed with *Carissa spinarum*, *Myrsine africana* and *Pyrus pashia*.

(*v*) Between 4,000 to 6,000 feet. *Berberis* spp., *Myrsine africana*, *Pyrus pashia*, *Quercus incana*, *Rhododendron arboreum* and *Pieris ovalifolia*. This type indicates that the *chil* is extending into what was in the recent past the *Quercus incana* zone, due to retrogressive changes in the soil.

As a general rule both on sandstone and conglomerate the associations are similar to those described above provided there has been no fire. On conglomerate fire causes greater recession of the factors of the locality and results in the formation of an association of a lower altitude.

B. Classification of the sub-montane scrub forests.—The sub-montane scrub forests can be classified as under for elevations 1,000 to 2,000 feet.

(*i*) Species of riverain influence. They are met with in places where during the rainy season flowing water forms new layers of sand and clay, *e.g.*, *Dalbergia sissoo* and *Nerium odorum*.

(*ii*) Forests of moist locality or vegetation of moist locality. *Eugenia jambolana* var. *caryophyllifolia*, *Ficus glomerata*, *Cedrela toona*, *Celtis australis*, *Salix tetrasperma*.

(*iii*) Dry thorn vegetation. *Acacia catechu*, *zizyphus jujuba*.

(*iv*) Dry forests. *Acacia arabica*, *Carissa spinarum*, *Dodonæa viscosa*, *Adhatoda vasica*, and *Euphorbia royleana*.

(*v*) Mixed deciduous forests. *Terminalia* spp. *Bombax malabaricum*, *Anogeissus latifolia*, *Phyllanthus emblica*, *Ougenia dalbergioides*, *Odina wodier*, *Cassia fistula*, *Dendrocalamus strictus*, *Pistacia integerrima*, scattered trees of *Pinus longifolia*.

C. Effect of fire between 2,500 *to* 3,000 *feet.*—Effect of fire was studied in a locality where the original community consisted of *Carissa spinarum*, *Colebrookea oppositifolia*, *Elaedendron glaucum*, *Flacourtia ramontchi*, *Randia dumentorum* and *Tylophora hirsuta*. Apparently the area had suffered from fires in the past. The flora after the fire consisted of the above species, *Dodonæa viscosa*, *Woodfordia floribunda*, *Rhamnus triqueter*, *Phyllanthus emblica*, *Anogeissus latifolia*, *Mimosa rubicaulis*, *Acacia catechu* and *Zizyphus jujuba*. *Euphorbia royleana* made its appearance at a later stage. *Desmodium* creeper and *Flemingia* became common over the entire burnt area.

In the low hills generally, a light fire generally helps in the propagation of *Carissa*, but if the soil becomes shallow *Dodonæa* becomes the dominant species. After repeated fires or a severe fire vegetation is dominated by *Woodfordia floribunda*, *Mimosa rubicaulis* and *Dodonæa viscosa* while trees of *Acacia catechu* come to establish themselves later on. A very severe fire or repeated fires lead to the establishment of *Acacia catechu* and *Zizyphus jujuba* and other scrub trees mentioned under *A* (*i*). Near 3,000 feet, *Indigofera*, *Rhamnus triqueter* and *Casearia tomentosa* follow repeated fires. At higher elevations fires are rare and their effect cannot be correctly studied, but the probable sequence of progressive desiccation can, however, be anticipated.

Turner (7) writing about the Kumaon *chil* areas says that a combination of slash and incendiary fires is often responsible for a remarkable change in the composition of vegetation. An original pure crop of *chil* seedlings may be replaced by broad leaved species such as *Rubus ellipticus, Indigofera pulchella, Rubus parvifolia, Pieris ovalifolia, Glochidion velutinum* and various species of grasses, *e.g., Andropogon monticola* and *contortus* which enter after a fire and continue to remain until *chil* again monopolises the ground. If the destruction of the young *chil* crop has not been complete then the *chil* occurs in groups interspersed with broad leaved species or grasses. The change may thus be complete or partial. In the former case, a consociation is replaced by an association and in the latter, remnants of a consociation form part of the association that has succeeded it.

The changed vegetation mentioned by Turner occurs at about 3,000 feet or over in Kangra, otherwise the description is equally true for Kangra. At lower elevations, as has been pointed out, the invasion of a large number of broad leaved species follows incendiarism. It is reasonable to conclude that the presence of a large number of broad leaved species (scrub) in an otherwise *chil* locality in the low hills of Kangra and Hoshiarpur has been due to repeated fires while shallow soil and comparatively heavy rain have helped in evolving a crop of a mixed nature. Shallow soil, with its aptitude for being readily heated, results in the dwarf growth of many species (8).

D.—Forest types based on rock or soil formation.—Efforts have been made to collect material to distinguish forest types based on rock and/or soil formation but so far without success. The low hills of Kangra and Hoshiarpur are subject to erosion, accelerated by unlimited grazing and fires and various forms and degrees of erosion (sheet erosion on sandstone, ribbed form on conglomerate and soft sandstone, fingering on marl, gully and mound formations on beds of marl, landslips on marl, etc.), give valuable information about pioneers and initial stages of succession but a good deal of further information is needed for a satisfactory classification.

For purposes of comparison, the associates of *chil* in the United Provinces are given below :—

Ranikhet (9).—*Chil* occurs between 3,000 to 7,000 feet. *Woodfordia, Rubus parvifolia* and *Glochidion* occur at low elevations while *Pieris, Myrsine* and *Rhododendron* occur at higher altitudes.

Central Almorah.—(10). The broad leaved associates of *chil* are *Glochidion velutinum, Ficus roxburghii, Indigofera pulchella, Indigofera dosua, Inula cappa, Plectranthus ternifolius ;* in the lower parts *Combretum nanum* (typically a fire line plant), *Engelhardtia colebrookiana, Bauhinia variegata, Aechmanthera tomentosa, Lespedeza stenocarpa,* while *Quercus incana, Rhododendron arboreum, Myrsine rubra, Pieris ovalifolia* and *Symplocos crataegoides* occur as trees. Others are :—

(*a*) Upper broad leaved spreading out from *nalas* or down from the oak zone, *Quercus incana, Rhododendron arboreum, Indigofera gerardiana* and to less extent *Myrica, Symplocos* and *Pieris.*

(*b*) Lower broad leaved, *Ougeinia dalbergioides*, *Eugenia jambolana*, *Wendlandia exserta*, *Phyllanthus emblica*, *Sapium insigne*, *Bridelia montana*, *Woodfordia floribunda*, *Colebrookia oppositifolia* and *Rhus parvifolia*.

(*c*) Cultivated areas are characterised by *Pyrus pashia*, *Crataegus crenulata*, *Rosa moschata* and *Berberis asiatica*.

East Almorah.—(11) *Chil* extends from 3,000 to 6,500 feet, the extremes being 1,100 feet and 7,500 feet. The common associates are relatively few in number and none form part of the crown canopy of the crop : of the trees, *Bauhinia variegata*, *Glochidion velutinum*, *Engelhardtia colebrookiana* and *Ficus roxburghii*. Of the shrubs, *Indigofera pulchella*, *Lespedeza stenocarpa*, *Flemingia fruticulosa* and *Aechmanthera tomentosa* are the more important. Other plants met with are :—

(*a*) Supposed to be stragglers from above, *Quercus incana*, *Rhododendron arboreum*, *Myrica nagi*, *Symplocos crataegoides* and *Pieris ovalifolia*.

(*b*) Supposed to be stragglers from below, *Ougeinia dalbergioides*, *Eugenia jambolana*, *Wendlandia exserta*, *Phyllanthus emblica*, *Woodfordia fruticosa*, *Colebrookia oppositifolia* and *Callicarpa macrophylla*.

There appears to be considerable similarity of ecological factors as compared with Kangra particularly at higher elevations though changes in vegetation appear quite marked and denote the effect of other factors or the intensity of similar factors.

II.—GROWTH FORMS.

Forest types can also be distinguished on the basis of growth forms and these growth forms give considerable information on the subject of succession and of the relative position of the type encountered in the scale of succession. No sound silvicultural measures can be undertaken anywhere without minutely studying the ecological succession in a given region, as what would be in nature a normal succession may be looked upon as retrogression by foresters who want to arrest the sere at a particular stage. The possibility or otherwise of successfully combating a natural process requires considerable skill and study and necessitates the establishment of conditions favourable to one selected species and definitely unfavourable to others.

In the zone referred to above the ground in the first instance was probably covered by pioneers like the *bhabar* grass and *Iseilema laxum* followed by *Dodonæa* and *Woodfordia* which were replaced and/or augmented by *Acacia catechu* and *Carissa*. In between the scrub scattered *chil* seedlings made their appearance and developed into poles above the average height of the scrub. On account of the inhibiting action of light on axial growth, they failed to attain a great height, but grew into large, spreading, branchy and malformed trees which in course of time came to have such large crowns that the forest appeared to be of overmature *chil* trees. This may be regarded as the first stage characterised by the growth form described in the preceding sentence. The competition among the species, however, did not stop though the *chil* had only established itself with considerable difficulty. The mature *chil* trees shed their seed and either failed to establish a pole crop or succeeded in reproducing themselves and transformed the area into a pole crop with scattered mature trees.

This established the second stage. Blanks came to be created with the death of the mature and other trees and which were filled up by *chil* seedlings or by an undergrowth of *Carissa spinarum* and *Dodonæa viscosa*. The struggle again ensued and the environmental complex determined the results. The condition of various forests and different parts of the forests may be shown thus according to the growth forms :—

Branchy, stunted, malformed and overmature *chil* trees mixed with and standing over scrub trees.

Stage A.

Chil trying to reproduce but competition with the scrub strong and the resulting tree growth (if any) generally malformed.

Stage B.

Reproduces malformed poles with scattered parent (mature) trees.

Stage C.

Trees remain inferior and reproduce only under favourable circumstances.

Stage D.

Reproduces itself and young *chil* crop with clean boles established, mature and malformed trees scattered.

Stage E.

Poles develop into mature trees and easily reproduce themselves and thus establish complete dominance.

Stage F.

Almost the entire *chil* bearing area can be classified under one of the above stages. It should be noted that it is not necessary that the stage F must have passed through all the preliminary stages. Stages E and F represent definitely favourable localities for *chil*. Difficulties are experienced for obtaining *chil* regeneration particularly in stages A to D.

V.—Silvicultural Operations.

20. For purposes of silvicultural operations, the forest types described in paragraph 19 may be reduced to the following treatment types :—

(*i*) The *Acacia-Zizyphus* type or briefly the A. Z. type.

(*ii*) The *Carissa-Dodonæa* type or the C. D. type. The presence of *Dodonæa* in this type is almost invariably due to the thinness and poverty of the soil caused by fires.

(*iii*) The *Berberis-Myrsine* type or the B. M. type. The little *Carissa* that may be met with in this type is the result of overgrazing and/or light fire.

It should be noted that these types are in no sense indicators of quality. Quality II may be met with in the A. Z. type and IV class trees may not be rare in the B. M. type. The forest types described in paragraph 19 are an expression of the environmental factors and are thus threefold indicators of (*i*) history of the past of the particular locality giving information of the previous stages of succession, (*ii*) exist-

ing conditions and the possible influence of prime controlling factors, (*iii*) of clues to the future possibilites (14). The reduction from five to three types is only for purposes of convenience ; in fact treatment should be guided by individual forest types. There is, therefore, some overlapping in the three types enunciated above.

As a general rule, it may be accepted that the development of female cones (*vide* Section II) is later in colder areas as compared with warmer regions.

21. From the succession and developmental history it is clear that " gross mass treatment " is unnatural and is likely to be uneconomical. The silvicultural treatment for the retention and regeneration of *chil* must vary with each type and this paragraph enumerates the more important modifications :—

(*a*) *Intensity of seedling fellings.*—In the A. Z. type or in the stage A (*vide* paragraph 19) seeding fellings are uncalled for or they should be of a very light nature. In the C. D. type they can be somewhat severer while the usual text book fellings are possible only in the B. M. type.

(*b*) *Other regeneration fellings.*—The speed and the number of secondary fellings is primarily determined by the rate of development of young regeneration. It will be found that the latter is quickest in the B. M. type, slower in C. D. type and slowest in the A.Z. type. The length of period should, therefore, be longer in the A. Z. type.

(*c*) *Thinnings.*—On the same principles, the fellings can be heavier in the B. M. type without causing any retrogression for *chil*. They should be of a very light nature in the A. Z. type.

(*d*) *Regeneration.*—Natural regeneration is perfectly easy to obtain in the B. M. type and in the more favourable areas of the C. D. type. Sowings are essential in the debased C. D. type and all over the A. Z. type.

In one of the Kangra forests (Kopra) belonging to the debased C. D. type, *Chil* has been regenerated by simultaneous sowings of *chil* and *Dodonaea*. The young *Dodonaea* plants afforded the necessary protection to the young *chil* seedlings at the critical period of their life. When the *chil* seedlings had established themselves, *Dodonaea* was cut back as it was then interfering with the development of *chil* on account of its more rapid growth during the early part of its life.

(*e*) *Débris burning.*—It is an important operation in the B. M. type and in the more favourable places of C. D. type but in the A. Z. type there is little to burn and the soil is so compacted and dry that it is converted into red brick by the heat generated by fire.

(*f*) *Sowings.*—A very judicious cutting of the bushes against the sun is necessary in the A. Z. and C. D. types but no such precaution is necessary in the B. M. type. The selection of the patch site is thus an important factor. The most suitable soil for the sowing of *chil* is indicated by the grasses, *Setaria*, *Andropogon annulatus* and *nardus* ; second best by *Heteropogon contortus*, *A. monticola* and *Iseilema laxum* while the worst is shown by the presence of *Imperata* and *bhabbar*.

(*g*) *Collection of seed.*—The collection of seed in the low hills can commence earlier but in higher hills it may start a month or so later.

(*h*) *Cleanings and weedings.*—In the B. M. type, a severe removal of bush and grass growth is found to be advantageous but in the C. D. and A. Z. types bushes and grass tend to create more mesophytic conditions for *chil* and should only be removed when the *chil* seedlings do not need their protection against desiccation.

(*i*) *Departmental burning in winter.*—This should be undertaken when the floral parts are in a resting condition, *i. e.*, the early part of the winter, and care should be taken that the flames do not reach the crowns of the trees. This may not seem important in quality I areas with little or no undergrowth but it is of considerable value in Kangra and Hoshiarpur where in some localities the crowns of trees are low and the undergrowth is heavy. When departmental burning is done late in winter or early spring, the floral parts are in a state of intense activity and greater damage is likely to be caused to the female cones and ovules (with a consequent reduction in the quality and quantity of seed) than in the early part of winter when the female cones are of a small size and brown in colour. The time for carrying out departmental burning should vary with the development of cones. Once the cones become green, the time for carrying out departmental burning should be considered as over. In warmer regions, it should be undertaken and completed early and in colder places it can be delayed, but in all cases it should be completed by the end or middle of January.

22. As a natural corollary to the theory of succession of forest types, it should be noted that in case of incendiarism or overgrazing, say in the B. M. type, the conditions after the fire would be more akin to the C. D. type and the treatment should be determined accordingly. In the course of a few years the changed vegetation gives ample testimony of the change in the factors of the locality. It may be mentioned that it has been observed as a general rule that the results of *chil* sowings in the rainy season immediately following a severe summer fire are not so satisfactory as the sowings carried out in the succeeding rainy season, probably on account of the recovery of soil from the desiccating effects of a disastrous fire.

VI.—Summary and Conclusions.

23. (*i*) Life history of *Pinus longifolia* is given in section II and it is suggested that the silvicultural operations should take into consideration the life processes. It is suggested that similar studies should be made of the principal associates of *chil* to determine and correlate the effects of the factors of locality.

(*ii*) Rainfall statistics for the *chil* zone are given, and it is suggested that in all publications, the number of rainy days should be given in addition to the usual figures of rainfall month by month. For determining the types of vegetation the " degree of wetness " during the dry months should be determined rather than the annual rainfall.

(*iii*) *Chil* and scrub forest types of Kangra and Hoshiarpur divisions are given in detail and it is shown that silvicultural treatment should be determined and modified according to the type encountered.

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